



Annual Industrial Capabilities Report to Congress

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Foreword

The post-Cold War defense budget drawdown of the 1990s resulted in a significant consolidation of the U.S. defense industry -- fewer prime contractors, rationalization of capacity in the industrial base, and substantial cost savings for the Department of Defense.

Today, nearly a decade after this process commenced, U.S. defense firms are experiencing an inevitable period of adjustment. They must meet 21st century warfighting needs and succeed financially in a very different defense market, with fewer large defense acquisitions, shorter production runs, and more uncertainty surrounding future defense programs.

Defense firms also are grappling with problems typical to any consolidating industry. Successfully absorbing acquired businesses is a complex process. Firms are restructuring and streamlining management, facilities and personnel, and dealing with the inevitable dislocations and debt burdens resulting from significant acquisitions. However, as with other industries, defense firms are working through these issues and taking the steps needed to remain competitive and innovative. They are streamlining operations, improving cash flow needed for financial stability, sharpening their focus on core markets, and shedding non-core assets as appropriate. Hence, today we have an industry that, while in a period of transition, nevertheless is providing cutting edge technology to U.S. warfighters.

A central challenge for the Department is to maintain competition in defense markets -- which is critical to providing affordable and innovative national security needs -- in the context of today's consolidated industry structure. As this report outlines, despite the recent consolidations, several capable firms remain in core defense market sectors.

For the future, the Department seeks to maintain competition by: 1) conducting disciplined, case-by-case reviews of mergers and acquisitions; 2) considering competition and industrial base factors in structuring acquisition programs (a number of policies now have been put in place); and 3) facilitating global sources of supply and pro-competitive industrial linkages with coalition partners.

The industry also faces other significant challenges, including the need to bring practices in line with those of commercial industry and to streamline operations. There remain areas of excess capacity in the industry that warrant attention. DoD has taken, and is taking, steps to address these issues through key acquisition reforms.

This report describes the current and emerging global security and industrial environments, and the multifaceted strategy that the Department has adopted to meet its national security responsibilities in those environments.

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Table of Contents

Foreword	i
Table of Contents	ii
1. Annual Report Requirements	1
2. Overview	2
3. DoD Industrial Statement	9
3.1 Security Environment	9
3.2 Defense Strategy	9
3.3 Defense Industrial Environment	10
3.4 DoD's Industrial Objectives/Initiatives	30
3.5 New DoD Policies	49
4. Assessments, Decisions, and Actions	51
4.1 Introduction	51
4.2 DoD-Wide	51
4.3 Army	55
4.4 Navy	62
4.5 Air Force	63
4.6 Defense Logistics Agency	67
4.7 Ballistic Missile Defense Organization	75
5. Related Activities	76
5.1 Industrial Capabilities Improvement Activities	76
5.2 Commercial Technology Insertion	82

1. Annual Report Requirements

Section 2504 of Title 10, United States Code, requires that the Secretary of Defense submit an annual report to the Committee on Armed Services of the Senate and the Committee on National Security of the House of Representatives, by March 1st of each year. The report is to include descriptions of:

- Department of Defense (DoD) industrial and technological guidance issued to facilitate the attainment of national security objectives, including that guidance providing for the integration of industrial and technological capabilities considerations into its budget allocation, weapons acquisition, and logistics support decision processes.
- Methods and analyses undertaken by the DoD alone or in cooperation with other Federal agencies, to identify and address industrial and technological capabilities concerns.
- Industrial and technological capabilities assessments prepared pursuant to section 2505 of Title 10, United States Code, and other analyses used in developing the DoD's budget submission for the next fiscal year, including a determination as to whether identified instances of foreign dependency adversely impact warfighting superiority.
- DoD programs and actions designed to sustain specific essential technological and industrial capabilities.

This report contains the required information.

2. Overview

A robust and competitive defense industry, at both the prime contractor and subcontractor levels, is vital to providing DoD with the high quality, affordable, and innovative products necessary to meet its responsibilities in the 21st Century. The Department's challenge is to foster an appropriate enabling framework for industrial development and competition in defense markets in an environment marked by dynamic change. Specifically, DoD's ability to execute its national defense strategy is predicated on its ability to access a supplier base that can: (1) design and produce next generation weapons; (2) innovate to preserve technological leadership; (3) reduce cycle times to respond to evolving threats; (4) lower costs; and (5) support interoperability for joint and combined operations with coalition partners.

Ongoing and remarkable changes in the global economic environment impact execution of the defense strategy. National borders increasingly are irrelevant to how businesses are organized and staffed. Among the consequences of industrial consolidation and globalization are multinational companies with interlocking corporate directorates and production presence in multiple nations. Byproducts also include the possible loss of some domestic industrial capabilities, on both sides of the Atlantic, and an increasing degree of mutual defense interdependence between the United States and its allies.

At the same time, the distinction between the civil and military industry sectors increasingly is blurred. The United States, as well as its friends and potential foes, relies increasingly on commercially and globally available technologies to develop or enhance military capabilities. Moreover, the rise of the Internet and other forms of communication have increased productivity significantly, changed ways of doing business, and increased cross-border information flows.

DoD believes that the competitive pressure of the marketplace is the best vehicle to shape an industrial environment that supports the defense strategy. Therefore, DoD takes action only when necessary to develop and/or maintain industrial and technological capabilities essential to defense that the marketplace, left unattended, would not.

The Post-Cold War budget drawdown inevitably resulted in a smaller, more concentrated defense industry.

Demand for defense products in the 1990s could not sustain the size and scope of the Cold War defense industry. The modernization portion of the DoD budget (Research, Development, Test and Engineering plus Procurement) declined 66 percent between Fiscal Years 1985 and 2000. Significant industry consolidation was inevitable. If firms were to sustain an adequate business base and cash flow in the face of dramatic demand declines, they had no choice but to consolidate. Given the relatively large number of competitors for shrinking defense programs and budgets, these transactions did not raise significant anti-competitive issues. Moreover, during this period, many transactions evidenced sizable cost savings accruing to DoD. Accordingly, for the most part, DoD approved the defense mergers proposed during the 1990s.

The U.S. defense industry consolidations have resulted in significant cost savings and industry rationalization. Critics have argued that defense industry consolidation has raised the costs of defense products to DoD and not produced sufficient consolidation savings. It may be that efficiencies could have been greater if firms had taken additional steps to rationalize and streamline facilities. However, the fact is that the most recent DoD report on external restructuring costs indicates that gross savings exceed \$4.4 billion and net savings to DoD exceed \$3.8 billion.

Today's defense industry, still in transition, has the reliable, robust, and competitive capabilities to meet critical defense needs.

The U.S. defense industry consolidation of the 1990s, viewed in context, has neither gone too far nor has it produced an industry in crisis. The U.S. defense industry continues to be the most technologically innovative, capable, and responsive in the world.

- In the U.S. industrial base supporting defense, several capable firms in each major product area and a viable supplier chain to support them compete for DoD programs.
- The ability of U.S. defense firms to innovate remains second to none. The successful development of the F-22 and Joint Strike Fighter (with new technologies such as super cruise propulsion, advanced electronically scanned array radar, and improved and more durable stealth capabilities) highlights the technical challenges U.S. industry has met.

A return to traditional profit margins, significant declines in the price of certain stocks, and plummeting market capitalization of leading defense firms led some observers to question the future health of the U.S. defense industry.

The changing financial performance of defense firms is related closely to merger and acquisition activities. These activities and a cyclical maturing of contracts -- both largely short-term phenomena -- created a cash/profit bulge in the mid-1990s that generated "growth" and growth-like performance on Wall Street. Then, prime level mergers slowed and significant legacy programs wound down. The combination of declining revenues and increased debt burdens tightened profit margins for some firms and adversely affected firms' bond ratings and the cost of capital. While the market capitalization of most defense firms has been affected by these developments, there is no clear indication today that the defense industry as a whole is experiencing a significant financial crisis. Operating earnings per share for the large defense firms generally increased during 2000. Additionally, while performance in financial markets is not DoD's leading metric in assessing the health of the industry, the significant appreciation of defense/aerospace stocks during 2000 is some measure of that health. Beginning in March 2000, aerospace/defense stocks began to rise and by November had appreciated over 70 percent.

The Department's central focus is to ensure that, in an era of industrial consolidation, the defense industry is financially stable, efficient, competitive and hence, capable of providing affordable, high quality, and innovative defense products to meet national security needs in the 21st century.

The U.S. defense industry is remaining competitive, innovative, and responsive by streamlining operations, improving cash flow needed for financial stability and investment, sharpening focus on core markets, and shedding non-core assets as appropriate. DoD is creating an environment that helps.

- Upward trends in DoD's modernization accounts coupled with the potential for modest increases in the amount of operations and maintenance funds available to defense firms will mean more business opportunities for the now smaller pool of defense firms.
- To ensure that U.S. defense firms remain preeminent in their ability to innovate, DoD is (1) strengthening Science and Technology budgets; (2) making participation in DoD research and development efforts attractive unto itself, regardless of the likelihood of subsequent production contracts; and (3) clarifying that the costs of bonuses required to recruit and/or retain employees with critical skills are allowable costs to defense contracts.

DoD is acting to maintain competitive sources in an era of defense industrial consolidation.

The presence of a sufficient number of capable suppliers in core defense markets fosters both competition and the innovation vital to superior warfighting.

- Competition produces industrial efficiencies that lead to improved affordability. The presence of robust, credible competitors creates incentives for firms to make their operations as lean as possible, and to bid the "best value" package of price, performance, and reliability on weapon system programs.
- The role of competition in stimulating innovation in defense markets is paramount in an unsafe world where technological superiority on the battlefield provides critical military advantage. Incumbent firms on major DoD programs may be less willing to take a risk to create a new market or to apply "leap ahead" technologies. In contrast, a firm that is not a current market leader may have fewer opportunities to gain market share or position, and so may take the risk to gain a lead by proposing a novel or aggressive new design.

DoD undertook a series of acquisition and other reforms during the 1990s to revolutionize how DoD does business with industry, to lower procedural and business barriers for commercial firms pursuing defense business, and to promote efficiencies in defense firms. Many of these reforms are intended to help expand competition in certain product areas, particularly in third and lower tier product markets. The Department is updating and codifying these buying concepts and practices in DoD Directive 5000.1, "Defense Acquisition System;" DoD Instruction 5000.2, "Operation of the Defense Acquisition System;" and DoD Regulation 5000.2-R, "Mandatory Procedures for Major Defense Acquisition Programs and Major Automated Information System Acquisition Programs."

Within this framework, the Department is addressing the challenge of maintaining future competition by:

- 1. Rigorously assessing proposed mergers on a case-by-case basis under established procedures.*
- 2. Considering competition and industrial base factors in structuring acquisition and technology program strategies.*
- 3. Fostering efficiencies through increased internal industry restructuring.*
- 4. Strengthening pro-competitive, security-enhancing global industrial alliances.*

1. Continuing rigor in assessing proposed mergers on a case-by-case basis

Notwithstanding the more consolidated defense industry, there is no need to change DoD's established standards for case-by-case merger reviews, and no benefit for DoD in establishing a "bright line" policy of discouraging further consolidation or divestiture or encouraging a specific industry structure (for example, a public utility). As in the past, DoD will evaluate each proposed merger on its particular merits in the context of the conditions of the individual market involved and the changing dynamics of that market's structure. The significant consolidations in the industry do make DoD's analysis of mergers today more complex and difficult. For example, a consolidation from five suppliers to four in a product market raises fewer complex issues than a change from three to two. Therefore, while DoD's standards remain constant, prime contractor level mergers in today's concentrated industry likely would require a more detailed evaluation of competitive concerns than would have been required in 1995.

It is difficult to predict how industry will evolve. Defense firms may move to smaller, more manageable business bases or diversify toward commercial markets. However, a flexible regulatory approach ensures that industry can adopt appropriate business strategies to succeed in the new environment while at the same time allowing DoD's interests to be addressed.

2. Considering competition and industrial base factors in structuring acquisition and technology program strategies

While market forces often work to sustain credible competitive sources, a number of factors may operate to make firms less likely to remain in, or enter, defense-unique markets -- including limited demand and high market entry barriers. Today, for some critical and complex defense products, the number of competitive suppliers is, or will be, limited. Therefore, there may be exceptional circumstances in which the Department needs to act to maintain future competition. Accordingly, DoD has taken steps to ensure that DoD Components consider the effects of their acquisition and budget plans on future competition. In the last two years, the Department has put in place a series of policies directed specifically at enhancing DoD insight into industry and the competitive effects of DoD buying actions.

- Subcontractor Competition. In 1999 the Department issued a policy on subcontractor competition requiring program managers and contracting officers to increase insight into

the subcontractor selection process and intervene, where appropriate.

- Anticompetitive Teaming. Also in 1999, DoD issued a policy challenging anti-competitive teaming arrangements. This policy required DoD program managers and contracting officers to scrutinize prime or subcontract teaming arrangements for their potential to inhibit competition.
- Future Competition for Defense Products. In July 2000, the Department put in place a new competition policy requiring that DoD consider the effects of its acquisition and technology strategy and budget plans on future competition. The policy requires: (1) improved visibility into cases where competition may be at risk (for example, where two or fewer competitors exist) and (2) a process to ensure that these risks -- which often transcend a single program and apply to an entire product market -- are assessed on a Department-wide basis.

Collectively, these policies are intended to increase DoD's focus on industry considerations in acquisition and technology program strategies, proactively. They also address the concerns of small and mid-size companies that increasingly feel squeezed out of competitions as large defense firms become more vertically integrated.

3. Fostering efficiencies through increased internal restructuring

Despite extensive consolidation and mergers, evidence suggests that U.S. defense firms still have opportunities to undertake *internal* restructuring (streamlining and disposal of assets not directly resulting from mergers and acquisitions) that reduce underutilized capacity, bring more efficient processes on line, and reduce net costs to DoD. Recent DoD-sponsored studies indicate, for example, that the fixed-wing aircraft, solid rocket motor, satellite, and shipbuilding industries, and Army-owned ordnance fabrication facilities, have retained significant underutilized capacity (facilities, equipment, and manpower) -- at some expense to DoD and the taxpayers. Internal restructuring actions could allow defense firms to adopt commercial processes and increase the flexibility of their manufacturing lines. Such changes could produce efficiencies that reduce the costs of products to DoD and allow firms to better leverage opportunities for commercial and military product or business integration. The Department therefore is encouraging defense firms to take appropriate internal restructuring steps to rationalize assets and facilities and streamline operations, thereby lowering overhead costs.

4. Strengthening pro-competitive, security-enhancing global industrial alliances

To facilitate continued competition, the Department also is taking steps to broaden its potential supply of reliable sources globally and create opportunities for U.S. firms to compete abroad.

Strengthened U.S. industrial linkages with key coalition partners in Europe, Asia, and elsewhere can facilitate interoperability among coalition forces, improve coalition warfighting, and promote competition in defense markets. The Department favors industrial teaming, joint ventures, and other forms of collaboration with coalition partners that are pro-competitive and security-enhancing.

Under a competitive transatlantic industrial model -- with industrial linkages among multiple firms on both sides of the Atlantic and technology sharing subject to security safeguards -- both the United States and Europe would realize benefits of competition and interoperability. Additionally, NATO would be strengthened, the large U.S. and European markets opened to transatlantic firms, and proliferation incentives in the third world significantly decreased. This approach ensures that U.S. firms have both enhanced access to European defense markets and reciprocal access to leading technologies.

The undesirable alternative -- a Fortress U.S./Fortress Europe approach -- could result in the separate evolution of U.S. and European military technologies, undermine interoperability, and lead to sole source European firms selected as suppliers for political purposes.

To ensure that national security is maintained within the competitive transatlantic model, DoD is:

- With the State Department, supporting export control reform by speeding up the process of processing munitions export requests to benefit U.S. trading partners while maintaining the export controls necessary to safeguard national security. (DoD has significantly reduced the time it takes to complete its internal license review -- down to about 20 days from over 46.)
- Participating in the Committee on Foreign Investment in the United States (CFIUS) by evaluating the national security aspects of proposed acquisitions of U.S. defense firms by foreign firms.
- Discussing multilateral and bilateral agreements with key allies to assure that the Department's non- U.S. defense suppliers will provide timely supplies in both emergency situations and during peacetime.
- Focusing on the need for compliance with the Organization for Economic Cooperation and Development's Convention on Combating Bribery when evaluating international transactions. The need for non-U.S. firms to "level up" in this area is clear.

U.S. firm are increasing their presence in Europe, mostly in the United Kingdom. Major defense and aerospace firms Boeing, General Dynamics, Lockheed Martin, Raytheon, and Northrop have subsidiaries there. TRW Aeronautical Systems is the only U.S. supplier with a large production and market presence in several locations in Europe -- not just the United Kingdom -- primarily due to its acquisition of Lucas Varity.

European companies -- particularly U.K. firms -- are entering the U.S. defense market by acquiring U.S. firms. BAE Systems North America now employs 18,000 people and had estimated revenues of \$2.4 billion in 2000. The United Kingdom's Smiths Industries also is active in the United States. Approximately 50 percent of Smiths Industries' revenues come from its U.S. operations. In the last year, DoD reviewed over 60 cases in which foreign firms sought to acquire U.S. defense firms, including:

- BAE Systems' acquisitions of Lockheed Martin's Aerospace Electronics and Control Systems businesses.
- British Nuclear Fuels' acquisition of ABB C-E Nuclear Power Inc.
- Smiths Industries' acquisitions of Fairchild Defense Division of Orbital Sciences and the TI Group.

In some cases, the U.S. firms being acquired either possessed critical defense technologies under development or were otherwise important to the defense industrial and technology base. In these cases, DoD imposed appropriate risk mitigation measures to eliminate national security concerns. Given the safeguards, DoD recommended the transactions be allowed to proceed.

The construction of a transatlantic "industrial bridge" is underway and accelerating.

3. DoD Industrial Statement

A robust, financially stable, efficient, and competitive defense industry, at both the prime contractor and subcontractor levels, is vital to providing DoD with the high quality, affordable, and innovative products necessary to meet its responsibilities in the 21st Century. The Department's challenge is to foster an appropriate enabling framework for industrial development and competition in defense markets in an environment marked by dynamic change.

3.1 Security Environment

The United States continues to face a dynamic and uncertain security environment, with attendant security challenges, including:

- Direct threats to the United States, including missile, terrorist, information, and nuclear, biological, and chemical (NBC) weapons attacks.
- The threat of cross-border aggression against U.S. allies and friends in key regions by hostile states.
- Internal conflicts in foreign states (including civil wars, internal aggression, and armed uprisings) that can threaten U.S. interests.
- Development, proliferation, and employment of NBC weapons.
- Transnational threats, including terrorism, organized crime, piracy, illegal drug trade, and other violent threats to U.S. institutions and citizens at home and abroad.
- Humanitarian disasters, including failed states, famines, floods, and other natural disasters requiring the unique capabilities of U.S. military forces.

3.2 Defense Strategy

In the 21st century, the Department must maintain its military superiority in the face of evolving, as well as discontinuous, threats and challenges. Without such superiority, the ability of the United States to exert global leadership and to create international conditions conducive to the achievement of the nation's goals would be in doubt. Specifically, the defense strategy directs the Department to:

- Help shape the international security environment in ways favorable to U.S. interests by promoting regional stability, preventing or reducing conflicts, and deterring aggression and coercion.
- Respond to the full spectrum of crises in order to protect U.S. interests, demonstrate resolve, and reaffirm the U.S. role as a global leader by deterring aggression and coercion

in crisis, conducting smaller-scale contingency operations, and fighting and winning major theater wars. U.S. forces must be able to conduct effective operations even in the face of NBC weapons and other asymmetric threats.

- Prepare now to meet the challenges of an uncertain future by pursuing the revolution in military affairs, exploiting the revolution in business affairs, and focusing modernization efforts.

The strategy also has given increased emphasis to the importance of joint and multinational force integration. The ability to lead and effectively conduct highly complex and integrated joint, multinational operations underwrites U.S. military preeminence. This proficiency can be achieved only through a unified effort by all elements of the Department toward the common goal of full spectrum dominance envisioned in *Joint Vision 2020*, the Chairman of the Joint Chiefs of Staff's blueprint for future military operations. Implementing *Joint Vision 2020* requires developing the doctrine, education, training, organization, and materiel to support truly integrated joint operations. Achieving this new level of proficiency also requires improving plans, doctrine, training, interoperability standards, and procedures for integrating U.S. military forces with those of its allies and coalition partners.

3.3 Defense Industrial Environment

Successfully implementing the defense strategy requires substantial and ready forces and a focused program of investments to improve the equipment these forces will employ. DoD's ability to execute this defense strategy is predicated on its ability to access a reliable (available when needed) supplier base that can: (1) design and produce next generation weapons; (2) innovate to preserve technological leadership; (3) reduce cycle times to respond to evolving threats; (4) lower costs; and (5) support interoperability for joint and combined operations.

Ongoing and remarkable changes in the world's economic environment affect execution of the defense strategy. National borders increasingly are irrelevant to how businesses are organized and staffed. Among the consequences of industrial consolidation and globalization are multinational companies with interlocking corporate directorates and production presence in multiple nations. Byproducts also include the possible loss of some domestic industrial capabilities, on both sides of the Atlantic, and an increasing degree of mutual defense dependence among the United States and its allies.

At the same time, the distinction between civil and military industry sectors increasingly is blurred. The United States, and its friends and potential foes, rely increasingly on commercially and globally available technologies to develop or enhance military capabilities. Moreover, the rise of the Internet and other forms of communication have increased productivity significantly, changed ways of doing business, and increased cross-border information flows.

DoD believes that the competitive pressure of the marketplace is the best vehicle to shape an industrial environment that supports the defense strategy. Therefore, DoD takes action only when necessary to develop and/or maintain industrial and technological capabilities essential to defense that the marketplace, left unattended, would not.

U.S. Defense Industry

Following the post-Cold War defense budget drawdown and significant mergers and acquisitions, defense firms are in a period of transition. These firms face the same issues confronted by any industry that undergoes such significant restructuring in such a short span of time -- rationalizing management, facilities, and personnel, and dealing with the inevitable dislocations and debt burdens.

Industry Structure

Figure 1 summarizes U.S. prime contractor presence for major military platforms. Despite significant restructuring and consolidation, there still is competition in major platform defense markets.

**U.S. Contractor Presence for
Selected U.S. Military Platforms
(1990 - 2000)**

Platform	Companies ¹ (1990)	Companies ¹ (2000)
Fixed-wing Aircraft	8	3
Launch Vehicles	6	3
Rotorcraft	4	3
Satellites	8	6
Strategic Missiles	3	2
Submarines	2	2
Surface Ships	8	3
Tactical Missiles	13	3
Tactical Wheeled Vehicles	6	3
Tracked Combat Vehicles	3	2

¹ Companies producing platforms in stated year. Not all produce all classes of platforms within a given platform area.

Figure 1.

Given the consolidated industrial structure that exists now, especially at the platform and major product area level, it is not surprising that several U.S. firms have developed a considerable defense market presence in multiple product areas. Of the 10 military platform areas summarized in Figure 1, one U.S. firm (Boeing) produces platforms in six of the areas, another firm (Lockheed Martin) in five, and another firm (General Dynamics) in three.

There always have been certain low demand, niche product areas where industrial capabilities are limited (see *Niche Product Management* later in this section). Generally, however, a viable supplier chain supports the prime contractors in each major product area (Figure 2).

**U.S. Contractor Presence for
Selected U.S. Military Product Areas
(1990 - 2000)**

Product Area	Companies ¹ (1990)	Companies ¹ (2000)
Ammunition ²	9	9
Electronic Warfare	21	8
Radar	9	6
Underseas Warfare	15	5
Solid Rocket Motors	5	5
Torpedoes	3	2

¹ Companies producing products in stated year. Not all produce all classes of products within a given product area.

² The number of ammunition companies reflects active government-owned assembly and explosive production facilities. DoD is considering reducing the number of these facilities.

Figure 2.

For those major product areas summarized in Figure 2, as was the case for military platforms, several large firms have a significant market presence. Raytheon and Northrop Grumman each produce products in four of the six product areas. Lockheed Martin produces products in three of the product areas.

Additionally, firms that provide platforms and major products for DoD applications now also have the ability to supply key subsystems for those platforms and products. For example, Figure 3 summarizes the number of suppliers available in key subsectors of the tactical missile platform area. Where indicated ("Y"), tactical missile prime contractors (Boeing, Lockheed Martin, and/or Raytheon) also have the capability to supply tactical missile subsystems.

Ability to Innovate

Military superiority is predicated on the ability to advance critical technologies and insert those technologies into defense systems cost-effectively. The United States possesses the most technologically superior military forces in the world, due in large measure to the most innovative industrial base in the world. However, U.S. defense firms now are challenged to maintain that

superiority at a time when the pace of technological change is accelerating and the Department is forecasting fewer major new systems, longer intervals between systems going forward, and smaller production runs. Heretofore, defense firms have kept their technical teams vibrant via a steady stream of new defense program work that allowed for -- indeed required -- continuous technology development and insertion. Absent significant major new defense system starts, research and development activities can sustain technological leadership. However, DoD funded research and development has declined in previous years. Independent Research and Development (IR&D), conducted by industry on its own initiative without direct DoD funding, also has decreased.¹ For major contractors, total annual IR&D spending is approximately \$2.9 billion, down 43 percent since the early 1990s. DoD reimbursements for IR&D spending now average about two percent of total audited defense contract costs, down from an average of 2.7 percent over the past 30 years.

U.S. Tactical Missile Subcontractors

Category	Subsystem	Number of Suppliers	Prime Involvement
Propulsion	Rocket Motor	5	N
	Case	7	N
	Jet Engine	2	N
	Fuel Tank	5	Y
Guidance & Control	Control Surface Actuator	9	N
	IMU	5	N
	GPS	3	N
	GPS/Antennae	5	Y
	Gyros/Accelerometer	4	N
	Data Link	5	Y
	Batteries	4	N
	Detector (Radar/IR/Optical)	5	Y
	Windows/Dome	6	N
	Electronics Unit	9	Y
Armament	Explosive Fill Assembly	6	N
	Inert Components	7	N
	Fuze	7	N
	Safe & Arming	8	N
	Kill Vehicle	3	Y
Airframe	Fuselage	4	Y
	Wing, Fin, Tail	6	Y
	Substructure	4	Y

Figure 3.

¹ Contractors recoup approximately one-half of IR&D spending as an indirect cost under defense contracts.

Additionally, defense firms have reported experiencing difficulty attracting and retaining the highest quality scientists, engineers, and computer programmers. The general expansion of the economy has allowed non-defense firms -- particularly those in the civil Internet, telecommunications, and high technology sectors -- to compete effectively for such people by offering attractive compensation packages and opportunities to participate in cutting-edge research efforts.

DoD is taking several steps to address these developments and ensure that U.S. defense firms remain preeminent in their ability to innovate. DoD is:

- Providing strong DoD Science and Technology (S&T) budgets by incorporating clear language in internal DoD planning documents and establishing a baseline of at least zero percent real growth above the Fiscal Year (FY) 2001 S&T budget request for the FY2002 S&T budget.
- Developing a comprehensive R&D acquisition policy that makes participation in DoD R&D efforts attractive unto itself, to both traditional defense and other nontraditional technology companies, regardless of the likelihood of subsequent production contracts.
- Removing redundancies in DoD's defense laboratories to eliminate duplication, ensure cost visibility, and ensure technical excellence into the future.
- Preparing proposed changes to Federal Acquisition Regulation cost principles to make it clear that the costs of signing bonuses and periodic retention bonuses are allowable if needed to recruit and retain employees with critical skills, and if comparable to bonuses being offered by firms engaged in predominantly non-government work.
- Developing a marketing plan to highlight innovative R&D work being performed in the defense community in order to attract technical talent to the defense community.

Efficiency

U.S. defense firms have engaged in significant industry consolidation via mergers and acquisitions. Although the DoD has no mechanism in place to catalog underutilized plant capacity (i.e., facilities, equipment, manpower) across the entire defense industry, it does appear that industry restructuring has not kept pace with reduced demand in several core defense sectors. For example, a recent study conducted by the Department with support from the Institute for Defense Analyses, found that, although DoD is procuring considerably fewer fixed-wing aircraft than it has in the past, the industry employs only one fewer fixed-wing final assembly facility than it did in 1985 (Figure 4).

Solid rocket motors (SRMs), used in space lift and strategic and tactical missile applications, represent an additional example. In 1990, five firms developed and manufactured SRMs. These firms remain today, despite a decline in U.S. industry SRM revenue from \$2.5 billion in 1991 to just over \$1 billion in 2000. Overall U.S. industry SRM production revenues are expected to climb to \$1.5 billion in 2002, to \$1.7 billion in 2006, and then decline through at least 2010. SRM industry rationalization appears both necessary and likely.

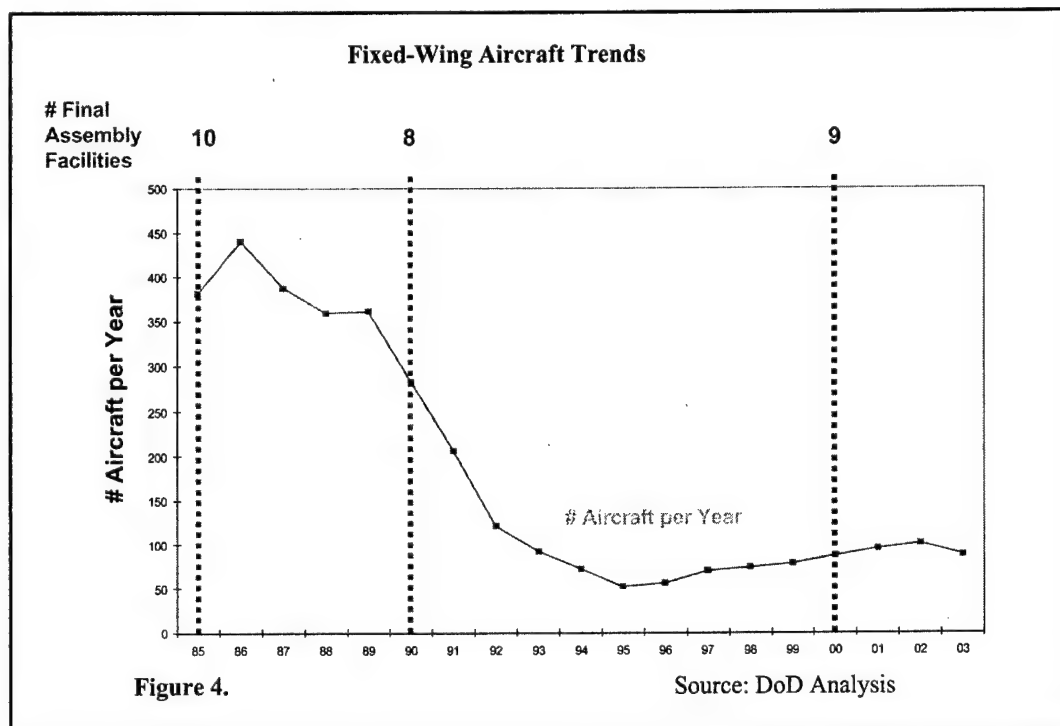


Figure 4.

Likewise, Booze Allen & Hamilton's December 2000 "Space Industrial Base Study" conducted for the Department concluded that the U.S. space industry has significant underutilized capacity. Between 2000 and 2015, the industry is expected to experience an average capacity utilization of 47 percent for large (greater than 7500 pounds) satellite buses, 48 percent for medium (3000 - 7500 pounds) buses, and about 80 percent² for small (less than 3500 pounds) buses.

For the past 10 years, the Navy has relied on six major shipyards to provide the design and construction capabilities needed to meet its surface and submarine force shipbuilding requirements. Unable to compete effectively for international commercial ship construction work, these yards rely on Navy ship construction requirements and relatively small amounts of commercial work for the domestic shipbuilding market. However, with the end of the Cold War and the subsequent downsizing of the naval fleet, these major shipyards vie for fewer and fewer Navy new construction programs. They have reduced their workforces significantly, but not their facilities. Collectively, the yards are operating at roughly 50 percent of capacity.

² Since the initial study was completed, Motorola has stopped building replacement Iridium satellites. In July 2000, capacity utilization for small satellites was estimated at approximately 40 percent.

Finally, a recent study conducted by the RAND Corporation for the Army concluded that there is significant underutilized capacity in Army arsenals and Army-owned ammunition plants.

Sustaining underutilized capacity such as that described above costs the Department hundreds of millions of dollars annually in overhead costs allocated to DoD programs.

One might argue that it is appropriate, from DoD's standpoint, that the defense and aerospace industry retain scientists, engineers, and facilities -- notwithstanding the downturn in demand -- in order to preserve "core" industrial and technological capabilities for the future. The validity of such a statement can be assessed only by balancing underutilized resources against cost and future demand, and determining the level of industrial and/or technological capability that must be maintained for a firm to compete effectively for the next opportunity. This is a matter difficult for DoD to evaluate. Firms faced with such decisions generally are better able than DoD to determine which skills and facilities should be maintained. The answer likely varies for each industry sector. Nevertheless, even given the need to maintain a sufficient number of competitive and robust suppliers with separate design teams, there still is significant underutilized capacity in key industry sectors.

Financial Performance

After 13 years of real decline between 1985 and 1998, the DoD budget increased 4.2 percent (from \$284 billion to \$296 billion) between FY2000 and FY2001 and is projected to continue increasing to \$317 billion in FY2005, an 11.6 percent nominal increase from FY2000. Particularly relevant to the defense industrial base, and often used as a proxy for the size of the defense industry, are the modernization accounts: Research, Development, Test and Engineering (RDT&E) and Procurement (Figure 5).

The modernization portion of the budget, sometimes referred to as the investment program, is increasing from \$93.4 billion in FY2000 to \$101.8 billion in FY2001 and is projected to continue increasing to \$107.2 billion in FY2005 -- a large market by any measure. In real terms, adjusted to compensate for inflation, the modernization accounts increased 3.2 percent from FY2000 to FY2001, and 3.6 percent from FY1999 to FY2000. (Figures quoted are from the National Defense Authorization Act for Fiscal Year 2001 and the National Defense Budget Estimates for FY2001 of the DoD Comptroller.)

This trend contrasts sharply with the first half of the 1990s in which modernization accounts, most notably and portentously procurement funds for new equipment, modifications, and initial spare parts decreased 55 percent in real terms between FY1990 and FY1997. Looking back to FY1985, the decrease was 66 percent in real terms. This sizable decrease is largely responsible for the expansive consolidation that occurred within the defense industry during this time. The reasoning for this effect is clear. As the portion of defense budgets available to defense companies decreased, the number of businesses able to exist profitably decreased as well, given the constraints of capital intensity and fixed costs associated with defense products. Furthermore, DoD acquisition plans forecasted fewer major new programs, with longer intervals

between new starts and lower production quantities. The imperative of this consolidation confirms the absence of sweeping improvements in efficiency and productivity that would be necessary to sustain a larger industry base. This suggests that industrial consolidation, at least at the second- and third-tier levels, still may be viewed as a work in progress.

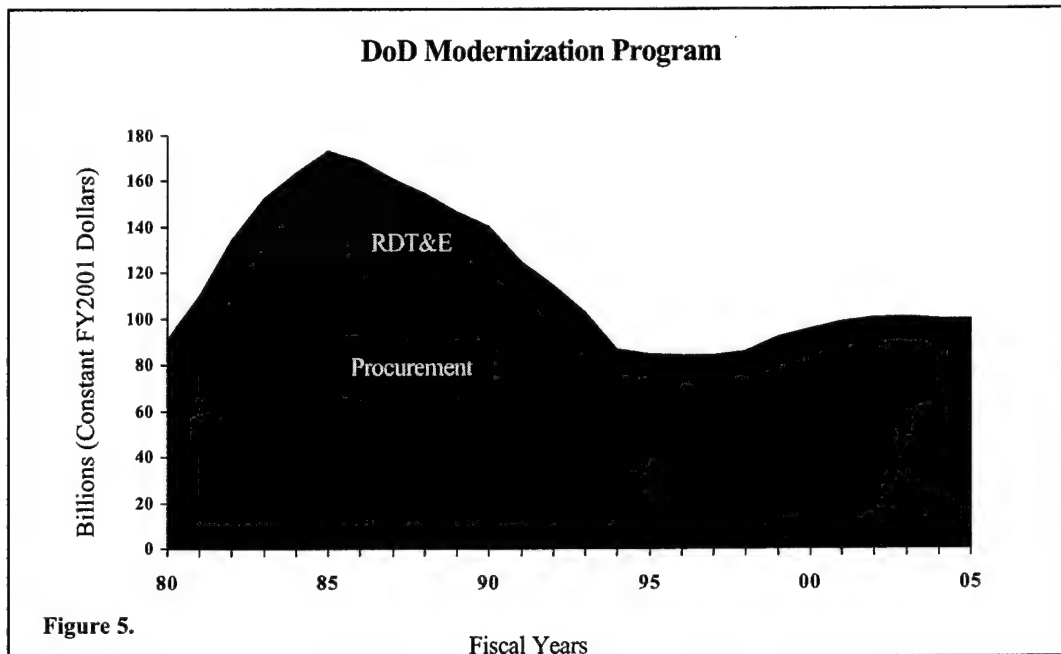


Figure 5.

A closer look at the procurement account as depicted in Figure 6 reveals that as a percentage of the total DoD budget, the funding level, although not as yet at a post-Cold War

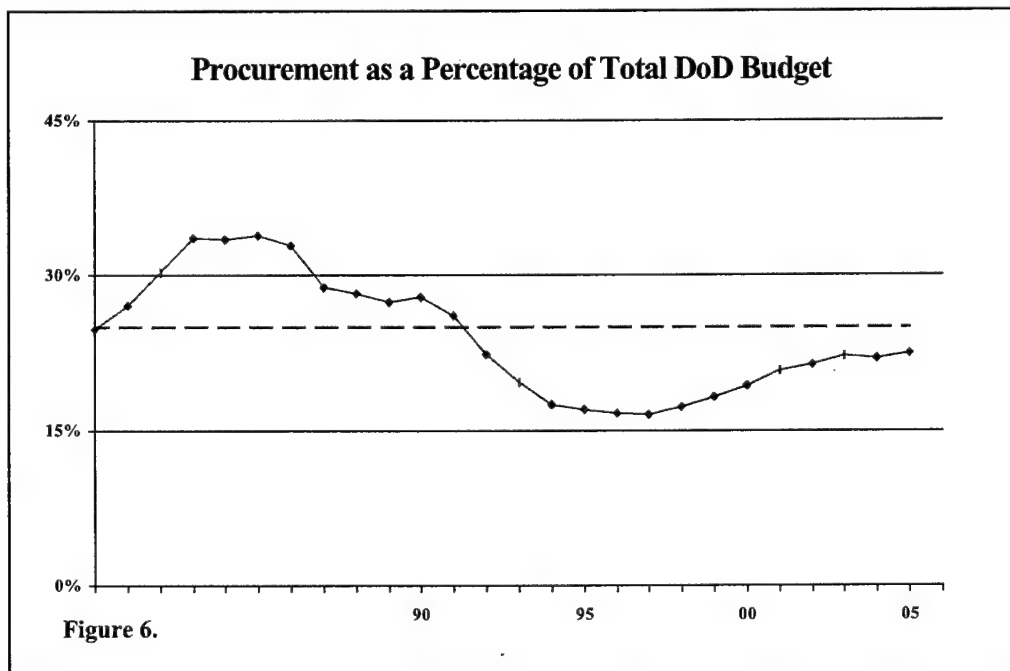
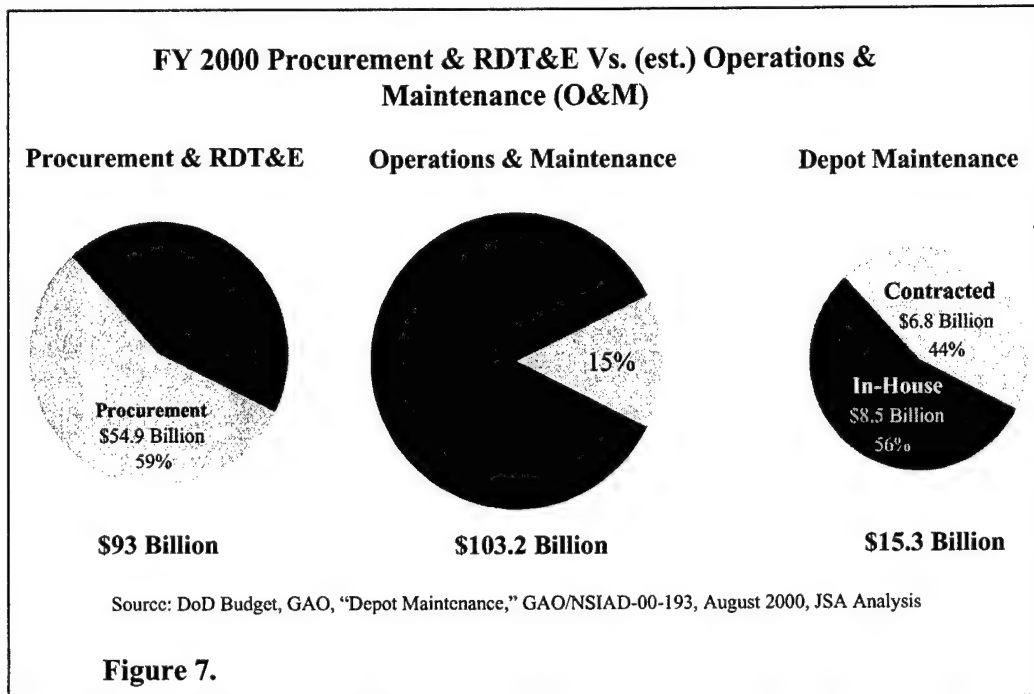


Figure 6.

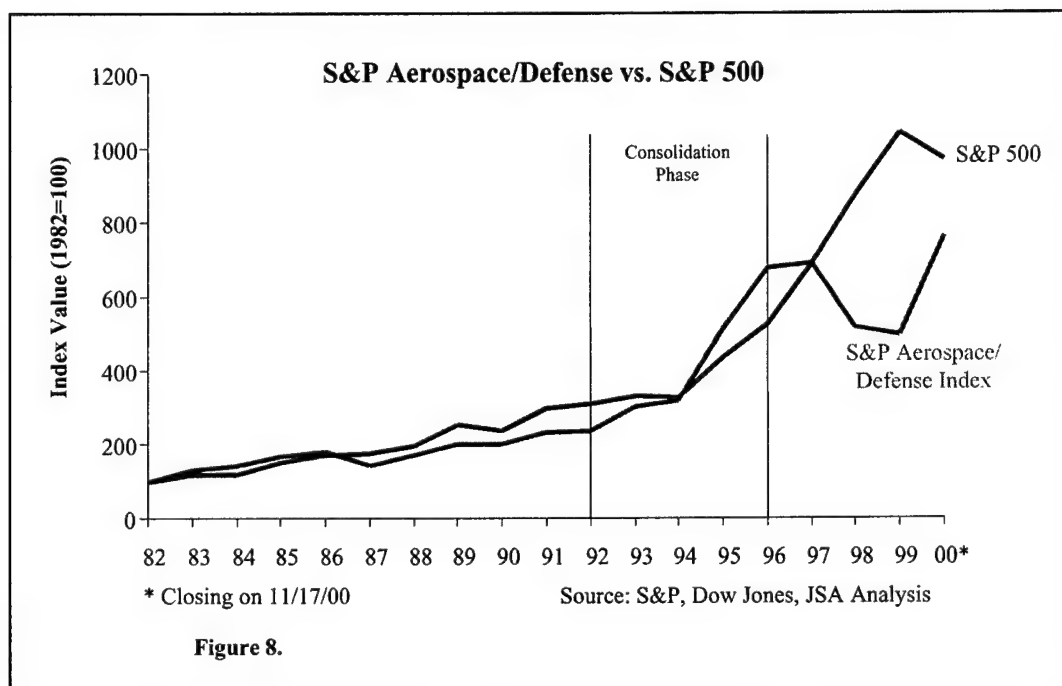
high nor the 20-year average of 25 percent, is increasing -- to 21 percent in FY2001. This reflects the Department's renewed focus on modernizing the warfighters' arsenal to preserve or increase technological superiority -- a cornerstone of the U.S. defense strategy going forward. This focus bodes well for defense firms.

Sources of some additional growth for the defense industry include the operations and maintenance (O&M) accounts, which traditionally are larger than the modernization accounts. As a means for DoD to save money and increase efficiency of operations, the Department has in the past sought to reduce operating overhead and infrastructure costs by privatizing a portion of O&M activities. Figure 7 illustrates that the estimated depot maintenance portion of FY2000 O&M expenses was \$15.3 billion. Of that, \$6.8 billion (44 percent) was contracted to the private sector. Contracted-out activities have remained a stable percentage of total O&M expenses in recent years and could obtain an increased percentage in future years as the DoD seeks to further reduce overhead costs and increase efficiency of support functions. However, section 2466 of title 10 of the U.S. Code restricts contracted-out depot maintenance work to 50 percent of the total of depot maintenance work.



In sum, the overall upward budget trend in the modernization accounts coupled with the potential for modest increases in the amount of O&M funds available to defense firms bodes well for the industry. Larger budgets mean more business for the now smaller pool of defense firms servicing the Department's needs. More business opportunities will create more robust competitions, which in turn should yield lower prices and more innovative solutions to meet the demands of the warfighter.

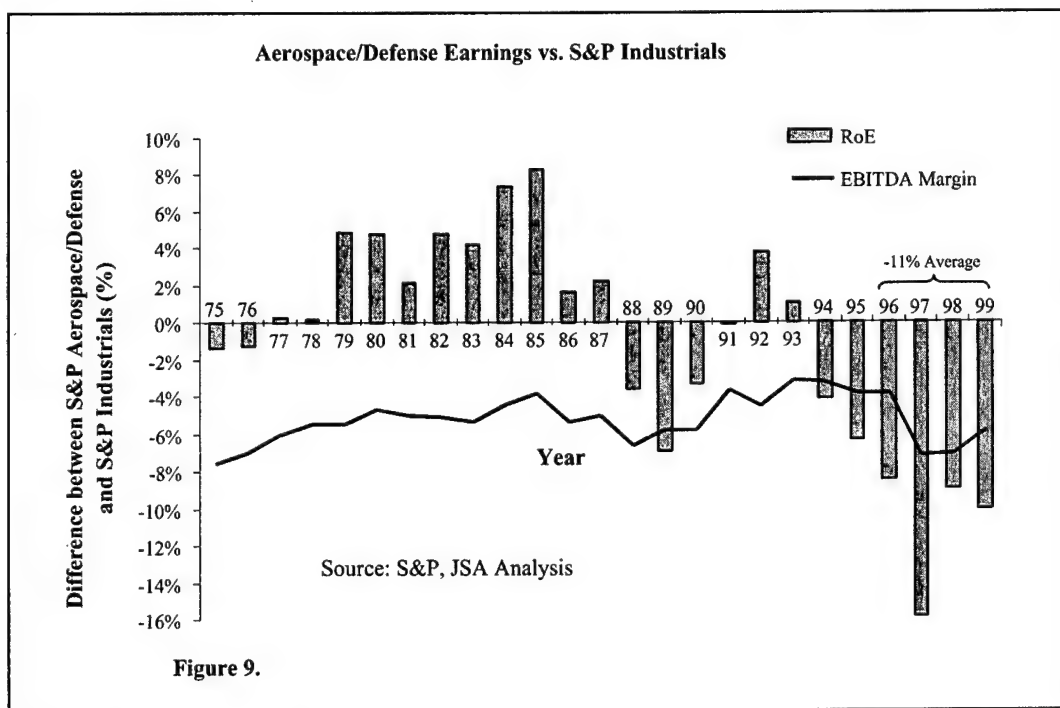
Suggestions by some observers that the defense industry is experiencing a financial crisis appear inaccurate. The aerospace/defense industry historically has under-performed the Standard and Poor's (S&P) 500, Dow Jones Industrials, and S&P Industrial indices (Figure 8). The market indices are indicators of aggregate price appreciation and thus reflect the increase in value of the component companies. From 1983 to 1999, the defense industry's aggregate value increased 400 percent while that of the S&P 500 increased over 800 percent. During the period 1994-1996, the defense industry actually outperformed the other three indices, supported by increased free cash flows from acquisitions and mergers. The indices themselves are only a proxy, not a direct indicator of the industry's ability to deliver low cost, high quality products. However, since market prices generally are based on factors such as the growth or stability of earnings and cash flows, the indices do reflect the relative financial performance of the sector.



FY 2000 was a particularly volatile year for the stock market in general, and the defense industry, specifically. Early in the year, major market indices continued to increase dramatically as capital flowed to commercial high technology and Internet equities at the expense of traditional "value-based" offerings that derive their value from steady rather than exceptional growth. However, the trend reversed and there was a flight to "value" stocks, including those of defense firms. This event coupled with the improved financial performance of aerospace and defense firms has resulted in increased sector stock prices, though valuations still lag behind those of the average S&P industrials.

The aerospace and defense sector historically also has not kept pace with the overall improvement in operating margins of other manufacturing sectors. The ratio of aerospace/defense industry earnings before interest, taxes and non-cash cost deductions to total sales (EBITDA margin) has historically lagged the S&P industrial average by about 6 percent (Figure 9), despite healthy and increasing EBITDA throughout the period of consolidations.

Furthermore, return on equity (ROE: earnings/shareholder equity) has significantly lagged behind that of the S&P Industrials in recent years. This low ROE is largely due to reduced profitability and the over-investment of the industry in acquisitions/mergers, much of it caused by the high premiums paid for goodwill. Another factor contributing to the disparity is the remarkable performance of non-defense industrials during this period, which also drove the index up.

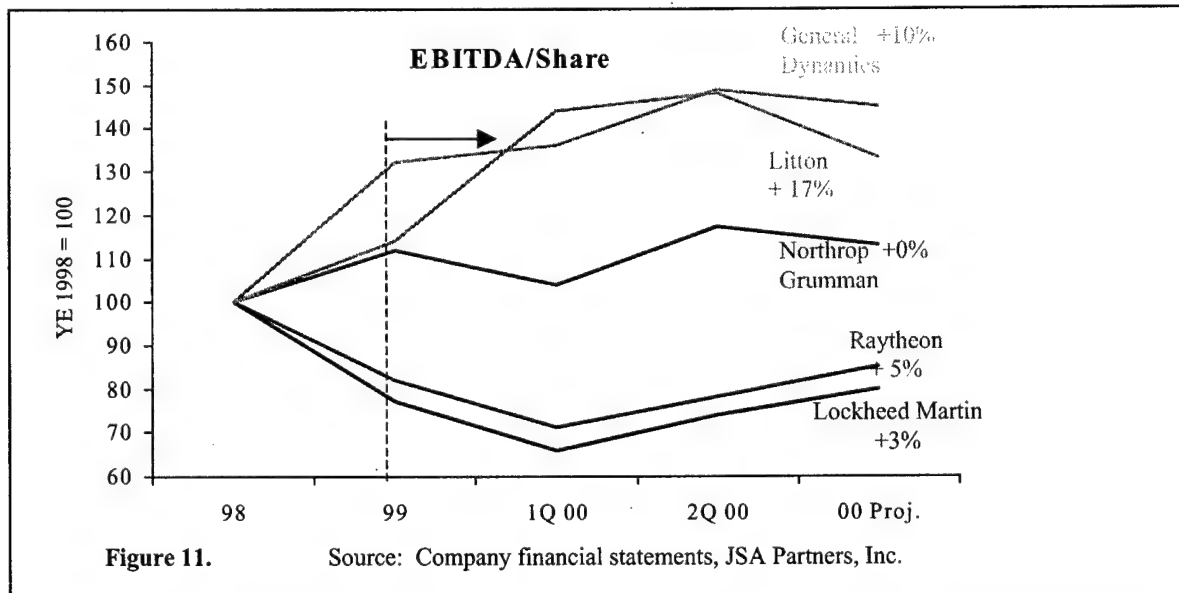
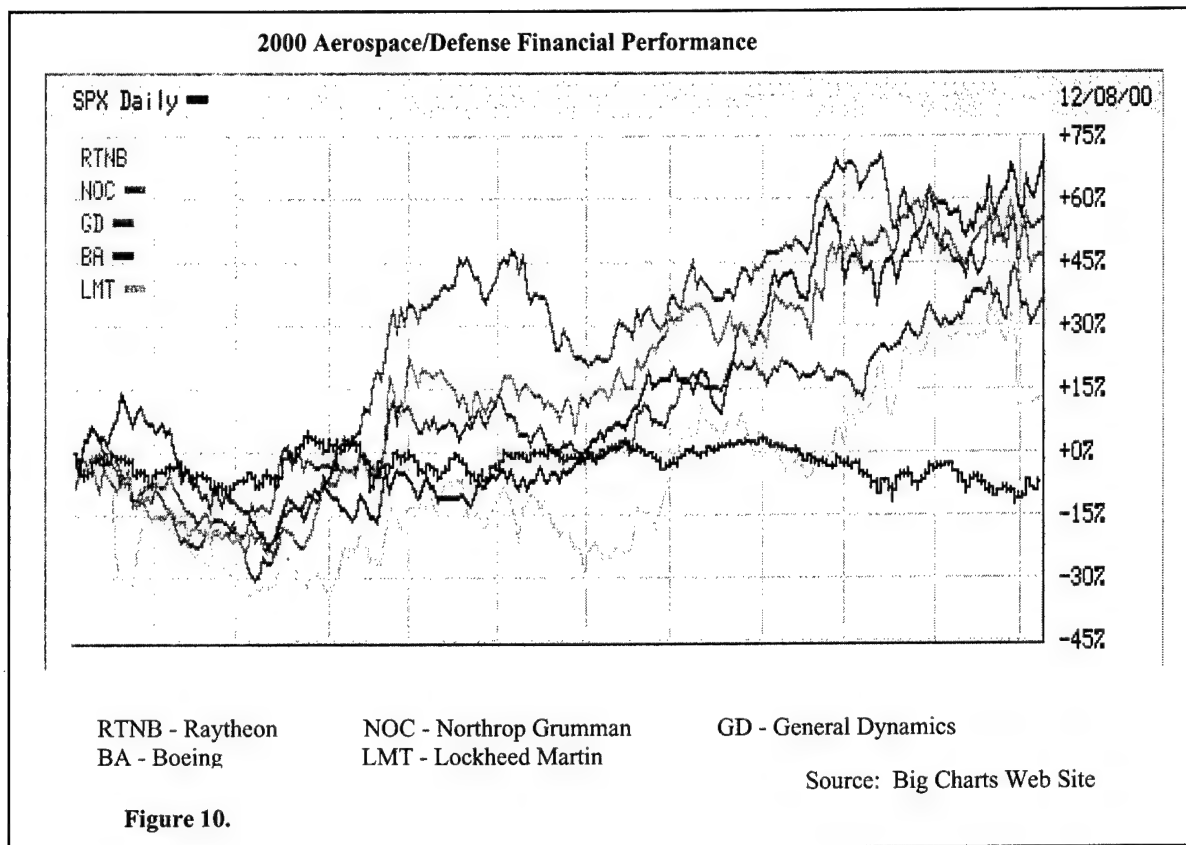


The continued improvement in the financial performance of the aerospace and defense sector is reflected in the upward trend in stock prices relative to the S&P 500 for five large defense firms during 2000 (Figure 10).

Additionally, operating profit per share has increased since 1999 for major defense contractors (Figure 11).

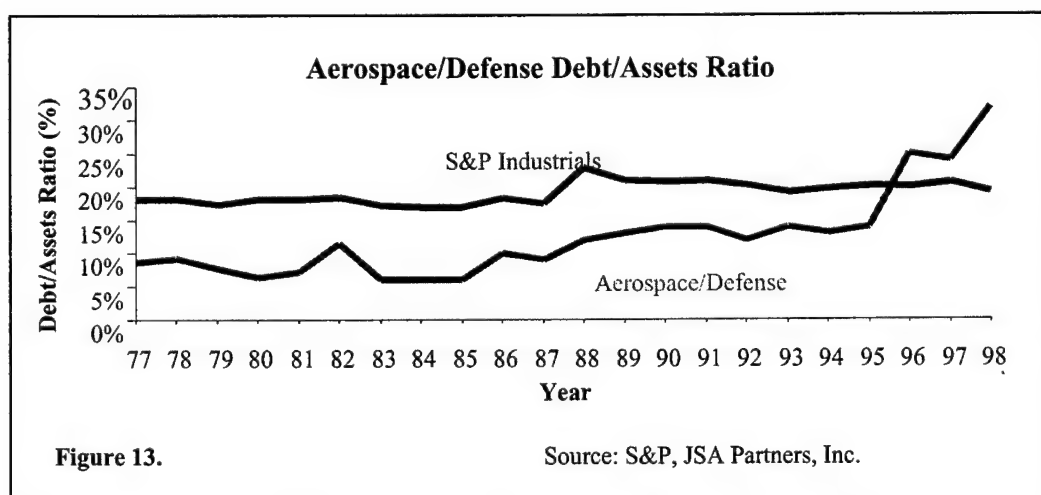
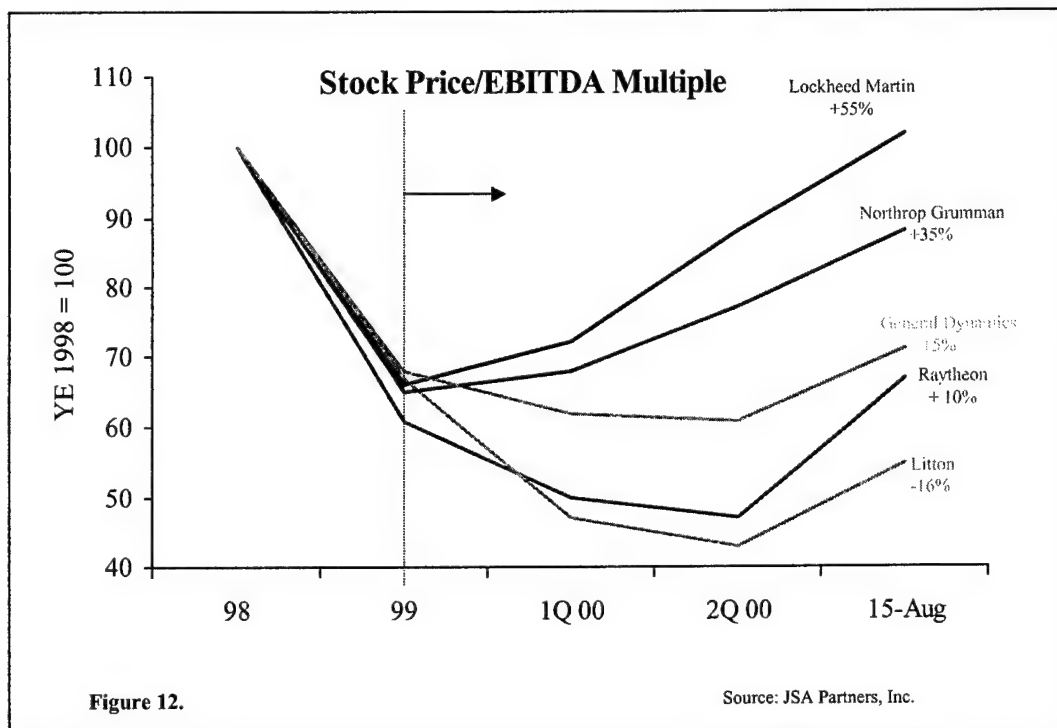
Finally, valuation multiples for large defense firms (except for Litton) also have risen since 1999, though they still lag behind 1998 levels (Figure 12). (The valuation multiple for Litton did increase in 2000.)

Historically, the aerospace/defense sector operated with a lower debt (relative to assets) than did S&P industrial firms (Figure 13). As a result of consolidations (acquisitions often paid for with borrowed cash) the aerospace/defense industry, on balance, has become debt-heavy. This debt, though concentrated in a few large firms, continued to have a profound effect on companies during 2000, tightening profit margins with both higher level and associated increased cost of debt.

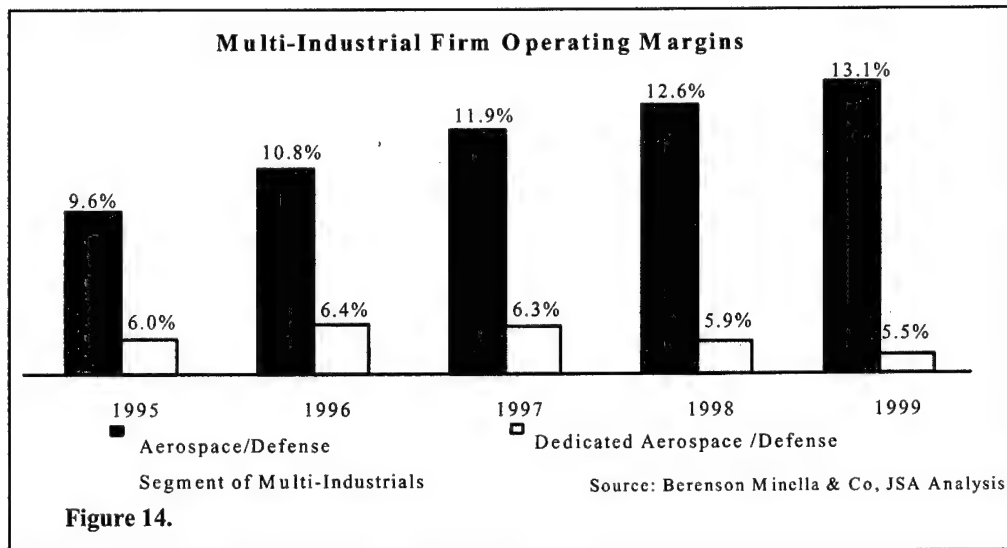


Evidence indicates that firms with a significant breadth of industrial business operations perform better than companies whose sole business is defense. Operating margins for multi-industrial firms (firms whose defense business is less than one-third of total business base) average nearly twice those of companies that are dedicated defense firms (Figure 14). These multi-industrial firms tend to have had a strong first-mover advantage in specific component and

sub-systems business areas that have commercial applications, allowing them to leverage non-defense business to the advantage of their defense operations. Generally, the barriers to entry in these businesses are sufficiently high to deter competition.



The Department is continuing to monitor the financial condition of the defense industry.



Summary

When the U.S. defense industry consolidation of the 1990s is viewed in context, consolidation has neither gone too far nor has it produced an ailing industry. The U. S. defense industry continues to be the most technologically innovative, capable, and responsive in the world.

- In the U.S. industrial base supporting defense, several capable firms in each major product area and a viable supplier chain to support them compete for DoD programs.
- The ability of U.S. defense firms to innovate remains second to none. The successful development of the F-22 and Joint Strike Fighter (with new technologies such as super cruise propulsion, advanced electronically scanned array radar, and improved and more durable stealth capabilities) highlights the technical challenges U.S. industry has met.

The U.S. defense industry is remaining competitive, innovative, and responsive by streamlining operations, improving cash flow needed for financial stability and investment, sharpening focus on core markets, and shedding non-core assets as appropriate.

The changing financial performance of defense firms is related closely to merger and acquisition activities. These activities and a cyclical maturing of contracts -- both largely short-term phenomena -- created a cash/profit bulge in the mid-1990s that generated "growth" and growth-like performance on Wall Street. Then, prime level mergers slowed and significant legacy programs wound down. The combination of declining revenues and increased debt burdens significantly tightened profit margins for some firms and adversely affected firms' bond ratings and the cost of capital. While the market capitalization of most defense firms has been

affected by these developments, it is important to note that some defense firms are in far better financial condition than are others.

In conclusion, there is no clear indication today that the defense industry as a whole is experiencing a significant financial crisis. Indeed, while performance in financial markets is not DoD's leading metric in assessing the health of the industry, the significant appreciation of defense/aerospace stocks during 2000 is some measure of that health. Beginning in March 2000, aerospace/defense stocks began to rise and by November had appreciated over 70 percent. (This rise, however, coincided with the downturn in the NASDAQ Composite Index. Historically, aerospace/defense stocks perform better when NASDAQ performance declines.)

Accessing World-Wide Industrial Capabilities

DoD must leverage the pressures of the market place, to the maximum extent feasible, if it is to be able to access and efficiently utilize the best industrial resources available -- defense and commercial, domestic and international -- to meet its needs.

Non-U.S. Suppliers Increasingly Important

Appropriate use of non-U.S. suppliers: (1) promotes consistency and fairness in dealing with U.S. allies; (2) permits DoD to access state-of-the-art technologies and industrial capabilities; (3) exposes U.S. industry to international competition, helping to ensure that U.S. firms remain innovative and efficient; (4) encourages development of interoperable weapons systems; and (5) encourages development of mutually beneficial industrial linkages that enhance U.S. industry's access to global markets. Therefore, DoD and many friendly governments have established reciprocal procurement agreements that waive respective "buy national" laws and put each other's industries on par as potential suppliers.

Projected operational scenarios eliminate most risks associated with using reliable, capable suppliers from allied and coalition partner nations. During the Cold War, DoD Components restricted certain procurements to domestic sources to preserve a base for furnishing needed supplies or services in case of a national emergency or industrial mobilization. Today, instead of planning for an attack by the Soviet Union and its allies, DoD bases its wartime planning needs on a requirement to fight and win two nearly simultaneous major theater wars primarily while using existing resources, including stockpiled materiel. Given anticipated response times, requirements to "surge" production and the need to maintain a "domestic mobilization base" are limited.

DoD, however, is not willing to accept a foreign vulnerability that poses risks to national security. There are two broad circumstances, both associated with *access* issues, that could merit exclusion of non-U.S. suppliers:

- When there is an unacceptable risk that DoD would be unable to access the capabilities, services, or products that it needs, when it needs them.

- When DoD must be able to deny to others access to capabilities, services, or products in order to preserve national security.

These conditions are addressed in more detail in DoD Handbook 5000.60-H, "Assessing Defense Industrial Capabilities." This handbook is available on the Office of the Deputy Under Secretary of Defense (Industrial Affairs) website.³

Cooperative Programs and Acquisitions

International armaments cooperation, in its many forms, enhances interoperability, stretches scarce defense budgets, and improves access to foreign defense industrial capabilities. It is a key element of DoD's acquisition and technology efforts to field the most capable force possible.

Many DoD weapons programs are, and will remain, national programs. However, the Department has embraced cooperative programs with its allies as a proven tool in achieving its military, political and business goals now and into the foreseeable future. Interoperability benefits to the coalition warfighter of cooperative programs are at least as important as business-related benefits. Increased interoperability, arising from common hardware and doctrine of use, and human interaction under cooperative programs and in exercises yields increased efficiencies on the battlefield and increases force protection. The United States has chosen to seek coalition partners for all of its major military operations in the past decade so as to shift some of the military, political, and economic burden to like-minded Allies and friendly foreign countries. It is likely that the United States will continue to confront the pervasive threats of the future alongside coalition partners.

Cooperative programs have facilitated greater multinational industrial competition and teaming. The government-to-government nature of cooperative projects has laid a groundwork, reassuring domestic and foreign industry that there are opportunities for them to compete in each other's home markets and work together when it makes business sense. It is also important to note that the U.S. defense industry does not enjoy technological leadership in all areas. Cooperative programs and foreign contracting also ensure DoD access to technologies and capabilities in which the United States does not have the lead.

There are numerous examples of cooperative programs and U.S. foreign procurements that illustrate the benefits of cooperative programs to the United States and the coalition warfighter. The Joint Strike Fighter (JSF) is the largest cooperative development program in which the U.S. has ever been involved. This aircraft program, which includes conventional take-off and landing, carrier, and short take-off and vertical landing variants, is preparing to enter its Engineering and Manufacturing Development (EMD) phase with the United Kingdom and other nations as cooperative partners. Italy plans to join in spring 2001; and the Netherlands, Denmark, Norway, Canada, and Turkey are considering EMD participation seriously. All of these nations have participated in JSF development in some fashion since 1995. A natural follow-on to previous partnership arrangements, JSF EMD international cooperation will realize

³ (<http://www.acq.osd.mil/ia/doc.html>)

substantial U.S. and foreign benefits -- cost sharing, technology leveraging, strengthened political military ties, and enhanced coalition interoperability -- all while meeting U.S. warfighting requirements.

The Medium Extended Air Defense System (MEADS) is a cooperative development program with Germany and Italy to develop a lower-tier component of the Department's Theater Missile Defense active defense pillar. MEADS is a highly mobile, tactically deployable system designed to protect the maneuver force from short range theater ballistic missiles, land-attack cruise missiles, and other air breathing threats. It will have the ability to provide point defense of critical assets while simultaneously also providing continuous protection to a rapidly advancing maneuver force when outside the umbrella of an upper-tier defense. MEADS builds on the capabilities developed under the Patriot program, but with significant improvements in system mobility, logistics footprint, and air defense effectiveness. German, Italian, and U.S. contractors are contributing technology and resources to the program. All participants foresee eventual production for this program.

The Multifunctional Information Distribution System (MIDS) is a cooperative development program among the United States, France, Germany, Italy, and Spain. It now is entering production. MIDS is an interoperable communications and data transmission system that will be installed in U.S. and partner air, sea, and land platforms, with capabilities exceeding those of existing national systems. The coalition warfighting interoperability achieved through this system will help counter many of the impediments to operational efficiency and force protection experienced in recent coalition operations. Contractors from each of the five participating countries have created a joint venture -- MIDSCO, Inc. -- to produce units for the engineering and manufacturing development phase of the program, and eventual production.

Both the U.S. Air Force and the Japanese Air Self Defense Force (JASDF) operate the F-15 aircraft, which uses the ACES II ejection system. The Air Crew Ejection System cooperative program with Japan is developing a modification kit to improve the ACES II ejection system in order to meet common U. S. Air Force and JASDF needs. This cooperative modification program will improve seat safety for high-speed ejections and qualify the seats for a wider population of aircrew members. The U. S. Air Force and the JASDF are sharing the costs of the development, which is being carried out via both U.S. and Japanese industry partners. Although the production plan for the modification kit has not yet been developed, it is likely that the kit will be produced both in Japan and the United States. This cooperative program reduces U.S. Air Force development costs and the improved seat will save lives.

The Department also is engaged in forums aimed at achieving Multinational Force Compatibility with its allies and likely coalition partners. NATO's Defense Capabilities Initiative is designed to improve defense capabilities and interoperability among NATO military forces, and partner forces where appropriate, bolstering the effectiveness of multinational operations across the full spectrum of Alliance missions. Combined with other military-to-military engagement activities, these programs go beyond seeking physical interoperability of systems. They pursue, as well, interoperability in the areas of tactics, techniques, and procedures. By promoting common thinking, the Department increases the potential for developing common requirements, and thus, more capable and interoperable systems.

Industrial Developments within the European Defense Industry

Strengthened U.S. industrial linkages with key coalition partners in Europe, Asia, and elsewhere facilitate interoperability among coalition forces, improve coalition warfighting, and promote competition across national markets. Accordingly, the Department favors industrial teaming, joint ventures, and other forms of collaboration with coalition partners that are pro-competitive and security-enhancing. Specifically, a competitive transatlantic industrial environment -- with industrial linkages among multiple firms on both sides of the Atlantic and technology sharing subject to security safeguards -- would allow both the United States and Europe to realize the benefits of competition and interoperability. In this environment, NATO is strengthened, the U.S. and European markets are open to transatlantic firms, and proliferation incentives in the third world are decreased significantly. This environment also ensures that U.S. firms have access to European and third country markets and to leading European technologies.

The Department is working to create the enabling environment necessary to facilitate security-enhancing, pro-competitive defense industrial linkages with its coalition partners. These linkages (discussed in more detail in the Maintaining National Security subsection of section 3.4) provide for greater transparency and efficiency in U.S. procedures for the export of defense articles with allies while maintaining necessary security.

U.S. defense firms traditionally favor equity investments over joint ventures, while European firms often focus on joint ventures with other European entities. However, cross-border (U.S. - Europe and intra-European) merger activity has increased each year since 1992 and the trend is expected to continue. Specifically, since 1996, cross-border transactions have increased in number, in value, and as a percentage of overall mergers and acquisitions. The construction of a transatlantic "industrial bridge" is underway and accelerating.

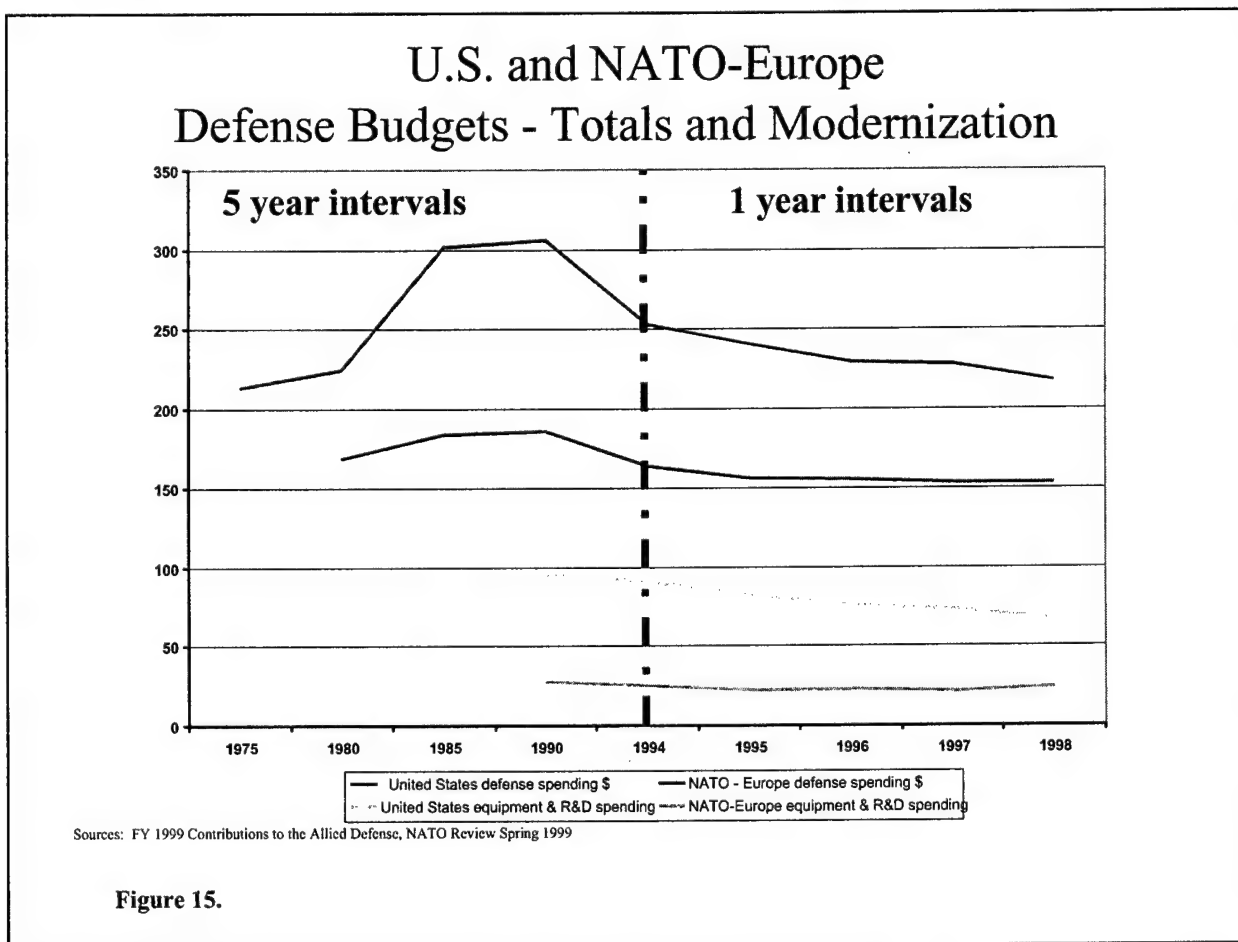
U.S. aerospace consolidations and mergers of the 1990s were a direct result of declining defense budgets. European NATO member defense budget reductions (Figure 15) encouraged European firms to do likewise.

In July 2000, Aerospatiale Matra SA (France), DASA Aerospace (Germany), and Construcciones Aeronauticas SA (Spain) merged their operations into one entity -- the European Aeronautic Defence & Space Co. (EADS). EADS, with annual revenues of about \$33 billion, now ranks among the world's largest aerospace and defense companies. EADS includes Airbus Industrie as well as defense and space operations and, effectively, is the new European counterpart to Boeing. It should prove to be a strong competitor to Boeing's commercial and military aerospace operations. The consolidation should facilitate the planned restructuring of Airbus Industrie and the launch of its new superjumbo jet. Alternatively, EADS is looking to enter the U.S. market by partnering with U.S. firms in both the military and commercial markets.

Collectively, EADS and BAE Systems (the other predominant European defense and aerospace supplier) will account for almost 75 percent of all European defense and aerospace

prime contracts. Today, one major supplier dominates most European defense and aerospace markets.

As a byproduct of consolidation and globalization, both U.S. and European firms are establishing or increasing their presence in the others' market area. According to a recent survey by KPMG Corporate Finance, U.S. firms invested \$154 billion in 1999 for mergers and acquisitions outside the U.S. (up from \$22 billion in 1990). Boeing, General Dynamics, Lockheed Martin, Raytheon, and Northrop Grumman have subsidiaries in the United Kingdom. General Dynamics also has subsidiaries in Italy and owns a portion of Steyr in Austria. Boeing owns 35 percent of Aero Vodochody (Czech Republic). However, TRW Aeronautical Systems is the only U.S. supplier with a large production and market presence in several locations in Europe -- not just in the United Kingdom -- primarily due to its acquisition of Lucas Varity (U.K.).



European companies are entering the larger U.S. defense market by acquiring U.S. firms. According to the same KPMG Corporate Finance survey, cross-border merger and acquisition investments in the United States increased from \$54 billion in 1990 to \$293 billion in 1999. For example, BAE Systems has established a significant U.S. presence over the past ten years via a series of mergers and acquisitions. BAE Systems North America employs 18,000 people and

had estimated 2000 revenues of \$2.4 billion. BAE Systems North America recently acquired Lockheed Martin Control Systems in a \$510 million cash transaction and the Aerospace Electronics Systems of Lockheed Martin (formerly the Sanders operations in Nashua, NH, Lexington, MA, Yonkers, NY, and Pomona, CA; the Fairchild Systems operation in Syosset, NY; and the Space Electronics & Communications operation in Manassas, VA) for \$1.67 billion. The United Kingdom's Smiths Industries also has been active in the United States. It recently acquired the Fairchild Defense Division of Orbital Sciences Corp. in Dulles, VA for \$100 million.⁴ Approximately 50 percent of Smiths Industries' revenues come from its U.S. operations.

As consolidation and globalization spread on both sides of the Atlantic, the longstanding government ownership of major European defense firms appears to be decreasing. For example, 32 percent of the French company Thompson-CSF is traded publicly; the company hopes to increase that to 46 percent. Additionally, 35 percent of EADS -- which includes France's Aerospatiale Matra SA, Germany's DASA Aerospace (formerly a unit of DaimlerChrysler) and Spain's government-owned Construcciones Aeronauticas SA -- is publicly-held.

Nevertheless, government ownership of major European defense firms continues; and such ownership encourages political input into major corporate strategies. The French government owns 97 percent of SNECMA, and 34 percent of Thompson-CSF. The Spanish government owns 100 percent of both Bazan SA and E.N. Santa Barbara. The Italian government owns 55 percent of Finmeccanica SpA.

Some observers have expressed concerns that European governments increasingly decide major procurements on a political -- rather than "best value" -- basis. As examples of this "Fortress Europe" mentality, the observers cite: (1) the United Kingdom's selection of the Meteor air-to-air missile; (2) the European Space Agency's refusal to provide funding to the joint venture between Pratt & Whitney and France's SNECMA to develop an upper-stage cryogenic rocket engine; and (3) efforts to develop and produce the European Future Large Aircraft.

At the same time, cooperative development programs such as JSF, MEADS, and MIDS (as discussed earlier) offer genuine opportunities to share costs, leverage technology, strengthen political military ties, and enhance coalition interoperability.

From both a competition and weapons proliferation perspective, a "Fortress U.S./Fortress Europe" industrial environment -- in which a pan-European firm and several large U.S. firms have closed home markets and compete only in the third world -- is not desirable. The United States prefers a transatlantic model with industrial linkages among multiple firms on both sides of the Atlantic. Such firms would compete effectively in both the U.S. and European markets, and share technology within an improved security environment.

⁴ The United States government evaluates plans of foreign entities to acquire U.S. firms (whether defense or non-defense) via deliberations of the interagency Committee on Foreign Investment in the United States. The Department participates in these reviews when firms providing goods and materiel to the DoD are to be acquired. This process is described in more detail in section 3.4.

If a "Fortress Europe" position solidifies, the ability of U.S. firms to compete for European R&D and procurement opportunities, which total about \$40 billion annually, will be limited. In 1999, U.S. firms exported defense equipment to Europe valued at almost \$2.5 billion. Reciprocal market access increases industrial linkages and interoperability. It also requires a two-way street. The United States and its allies must adopt greater reciprocity and be willing to rely on an integrated industrial base to satisfy their defense needs. DoD is monitoring the extent to which the European and U.S. markets remain open to all allied defense suppliers; and is working to ensure reciprocal market access on both sides of the Atlantic.

In addition to the cooperative programs and acquisitions described above, U.S. and European aerospace and defense firms also are entering into Business to Business (B2B) agreements to promote technology standardization, facilitate interoperability, and reduce inefficiency and unnecessary complexity. B2B agreements facilitate open, independent, vendor-neutral, global digital information exchange benefiting buyers and sellers. Several companies combine to establish an independent company with its own management and board of directors to link buyers and sellers via the Internet. Using the Internet, the participants buy, sell, and settle transactions; buy and sell catalogs; and conduct on-line auctions for supplies and services based on predefined specifications. In 2000, BAE Systems, Boeing, Lockheed Martin, Raytheon, and Commerce One created a B2B e-commerce venture (Global Aerospace and Defense Trading Exchange - Exostar) to establish a global trading exchange for the aerospace and defense industry. The five companies each hold an equity stake in the venture. However, the firms also set aside a large equity stake as an incentive for other firms to join. The B2B exchange is to have no controlling shares and industry firms, no matter how small or large, will be allowed to participate. Except for extremely sensitive military technology, the exchange is to sell almost all commercial and defense related products manufactured by the participating companies. Products to be sold include space and rocket components, missile parts, airplanes and aviation parts, munitions, and data systems.⁵

3.4 DoD's Industrial Objectives/Initiatives

A return to traditional profit margins, significant declines in the price of certain stocks, and plummeting market capitalization of leading defense firms have led some observers to question the future health of the U.S. defense industry. As important as short-term fluctuations in stock valuations or market capitalization are to the financial community, they do not represent core DoD concerns.

The Department's central focus is to ensure that, in an era of industrial consolidation, the defense industry is financially stable, efficient, competitive, and hence, capable of providing affordable, high quality, and innovative defense products to meet national security needs in the 21st century.

⁵ *Leading Aerospace and Defense Companies Create Global B2B Trading Exchange*, "Defense Daily," March 29, 2000.

Ensuring Competitive Sources

Several Defense Science Board studies⁶ have found that the presence of a sufficient number of capable competitors in core defense markets fosters both competition and the innovation vital to superior warfighting.

- *Competition produces industrial efficiencies.* The presence of robust, credible competitors creates incentives for firms to make their operations as lean as possible, and to bid the “best value” package of price, performance, and reliability on weapon system programs. DoD’s experience in dealing with ongoing sole source contracts in highly specialized program areas with limited demand places the importance of competition in stark relief. In such circumstances, DoD has experienced real challenges in sustaining efficiency, containing costs, and encouraging innovation.
- *The role of competition in stimulating innovation in defense markets also is critical in an unsafe world where technological superiority on the battlefield provides military advantage.* Incumbent firms on major DoD programs may be less willing to take a risk to create a new market or to apply “leap ahead” technologies. In contrast, a firm that is not a current market leader may have fewer opportunities to gain market share or position, and so may take the risk to gain a lead by proposing a novel or aggressive new design. Historically, when DoD has introduced competition into products or programs experiencing quality or reliability problems the result has been better products, such as was the case for the jet aircraft engine market and the Advanced Medium-Range Air-to-Air Missile program.

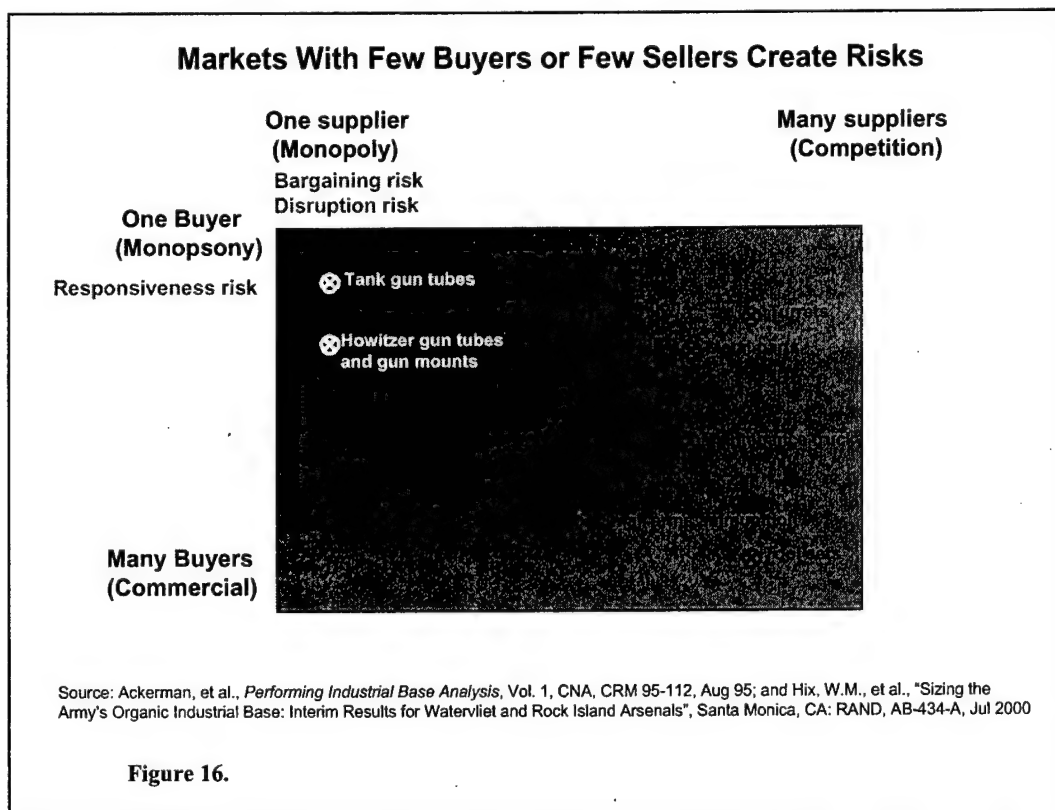
Clearly, there are trade-offs to be evaluated between encouraging both adequate competition and an efficient industrial structure. Downsizing to a monopoly environment in some defense markets could be structurally efficient in the *short-term*; but, in the longer-term, risks losing the benefits of competition for the next major contract award.

Some industry observers have stated that, given limited demand and the associated inefficiencies of sustaining competitors with underutilized industrial facilities, DoD should shift away from a competitive industrial model and toward a “public utility” or a nominally private, government arsenal model. The evidence suggests, however, that sole source and arsenal models support neither efficiency nor innovation.

As stated earlier, it is a fundamental DoD policy to allow market forces to shape the industrial environment to the maximum extent practicable. However, in cases where there are few buyers or few sellers, and market forces may be insufficient to foster competition, DoD must remain especially vigilant.

⁶ Defense Science Board Task Force Reports on: Antitrust Aspects of Defense Industry Consolidation (1994), Vertical Integration and Supplier Decisions (1997), and Effects of DoD Acquisition Practices on Defense Industry Health (2000).

The situation reflected in Figure 16, for example, is part of a study recently conducted by the RAND Corporation for the Army. The figure reflects issues associated with retaining the Army-owned manufacturing capabilities at Watervliet and Rock Island Arsenals. Figure 16 suggests that DoD vigilance should be focused on arsenal capabilities associated with tank and howitzer gun tubes and howitzer gun mounts (one buyer, few suppliers) rather than on small arms ammunition and tool sets (many buyers, many suppliers).



In a normal commercial product environment -- one characterized by multiple buyers and sellers -- the competitive pressures of the marketplace prevail and DoD can leverage those pressures to meet its needs. For situations in which it can access only one supplier (a monopoly situation) DoD is faced with potential risks associated with contracting with the monopolist for equitable prices, timely delivery, and acceptable performance; and supply disruption if the monopolist should stop producing. DoD also faces a responsiveness risk when it is the only buyer (a monopsony situation). In such cases, supplier capabilities and capacities are sized to meet only DoD demand. If DoD demand increases significantly, suppliers may be unable to increase capacity commensurate to demand. If DoD demand decreases significantly, suppliers may exit the business, calling into question DoD's ability to obtain the products or services it needs to fulfill its national security responsibilities. If there are many buyers for the product or service, increases in DoD demand likely can be met by leveraging supply capacities sized to meet the collective requirements of all of the buyers.

Given the consolidated industrial structure and a relatively flat defense modernization budget, DoD must remain vigilant to ensure that its actions foster an environment that sustains a sufficient number of capable competitors in core defense markets.

DoD has undertaken a series of acquisition and other reforms during the 1990s to revolutionize how DoD does business with industry, to lower procedural and business barriers for commercial firms pursuing defense business, and to promote efficiencies in defense firms. Many of these reforms are intended to help expand competition in certain product areas, particularly in third and lower tier product markets. The Department is updating and codifying these buying concepts and practices in DoD Directive 5000.1, "Defense Acquisition System;" DoD Instruction 5000.2, "Operation of the Defense Acquisition System;" and DoD Regulation 5000.2-R, "Mandatory Procedures for Major Defense Acquisition Programs and Major Automated Information System Acquisition Programs."

Within this framework, the Department is addressing the challenge of maintaining future competition in several important ways.

Merger and Acquisition Reviews

To address the complex issues associated with proposed mergers and acquisitions, DoD has established, and utilized for a number of years, a formal and rigorous review process.⁷ In this process, DoD, working with either the Department of Justice Antitrust Division or the Federal Trade Commission, evaluates four key areas of interest:

- Will the transaction result in a loss of current or future competition and innovation in defense product markets or for a specific DoD program (for example, through market concentration or loss of an important competitor)?
- Will the transaction have an adverse effect on DoD programs due to vertical integration (for example, one company potentially could control production of certain subtier products -- subassemblies or components -- that are critical to its competitors)?
- Does the transaction present organizational conflicts of interest (for example, a merged entity might be a partner in two different teams competing on the same program)?
- What cost savings/efficiencies might accrue to the Department as a result of the acquisition?

This approach reflects the reality that evaluating the consequences for DoD of a particular merger or acquisition can be done only on a case-by-case basis. There is no single criterion for all occasions.

⁷ As specified in DoD Directive 5000.62, *Impact of Mergers or Acquisitions of Major DoD Suppliers on DoD Programs*.

DoD has employed this approach consistently -- from the proposed mergers of Lockheed and Martin Marietta in 1994, to Lockheed Martin and Northrop in 1998, to Boeing and Hughes in 2000. What does change are the case-to-case facts associated with a specific transaction. In each case, the Department defines the relevant product market, and within that market examines competitive conditions horizontally and vertically. Current and projected market shares are a consideration, but not necessarily predominant. Defense markets tend to be long-term in nature; they are framed by decisions on long-term contracts rather than buying on a spot market. *Therefore, a key focus of DoD's merger analysis is on whether, after the merger, there remain additional firms with the design, production and other capabilities to compete in that product market for the next program award.* The Department also assesses the technology dynamics of each market, and the effects of the transaction on leading edge capabilities.

Notwithstanding the more consolidated defense industry, there is no need to change DoD's established standards for case-by-case merger reviews, and no benefit for DoD in establishing a "bright line" policy of discouraging further consolidation or divestiture or encouraging a specific industry structure (for example, a public utility). As in the past, DoD will evaluate each proposed merger on its particular merits in the context of the conditions of the individual market involved and the changing dynamics of that market's structure. The significant consolidations in the industry do make DoD's analysis of mergers today more complex and difficult. For example, a consolidation from five suppliers to four in a product market raises fewer complex issues than a change from three to two. Therefore, while DoD's standards remain constant, prime contractor level mergers in today's concentrated industry likely would require a more detailed evaluation of competitive concerns than would have been required in 1995.

In 2000, the Department formally reviewed 27 transactions (Figure 17). One proposed transaction was withdrawn; all others were approved. However, two cross-border transactions required consent agreements to protect continued competition. Under agreements with the Department of Justice and the European Commission, Alcoa agreed to sell a 25 percent interest in Reynolds Metals Company's Longview, WA smelter, plus Reynolds' interest in three alumina foundries (two in Europe and one in the United States). Under agreements with the Federal Trade Commission and the European Commission re the Boeing - Hughes transaction, Boeing will establish firewalls to ensure the confidentiality of launch vehicle information provided to Boeing Satellite Systems by various launch service providers, and also supplier satellite information provided to Boeing's Expendable Launch Systems unit.

It is difficult to predict how industry will evolve. Defense firms may move to smaller, more manageable business bases or diversify toward commercial markets. However, a flexible regulatory approach ensures that industry can adopt appropriate business strategies to succeed in the new environment while at the same time allowing DoD's interests to be addressed. The restructuring of the U.S. defense industry to date has produced significant benefits to DoD. For the 12 restructurings for which it has audited cost data, DoD expects to accrue net savings (after restructuring costs) of \$3.8 billion.

Calendar Year 2000 Defense Mergers and Acquisition Reviews

Acquirer	Acquiree	Value	Remarks
Smiths Industries plc	Sabritec	\$52.4M	
Dow Chemical Company	Union Carbide Corporation	\$11.6B	
Titan Corp.	Advanced Communication Systems Inc.	\$230M	
Alcoa	Reynolds Metals Company	\$4.4B	Consent Agreement
L-3 Communications	Raytheon TDTs	\$160M	
EDO Corporation	AIL Technologies	\$86.8M	
Boeing Company	Hughes Space & Communications	\$3.75B	Consent Agreement
Smiths Industries plc	BAE Actuation Systems Division	\$100M	
Alcoa	Cordant Technologies Inc.	\$2.3B	
BAE Systems North America, Inc.	Lockheed Martin Control Systems	\$510M	
General Dynamics	Saco Defense	N/A	
Lincoln Electric	Charter plc	\$742.8M	Withdrawn
Carlyle Group	Northrop Grumman ISA	\$843M	
Northrop Grumman	Comptek	\$155.6M	
BAE Systems North America, Inc.	Lockheed Martin Aerospace Electronics Systems(Sanders)	\$1.67B	
II-VI	Laser Power	~\$53.8M	
Smiths Industries plc	Fairchild Division of Orbital Sciences Corporation	\$100M	
Northrop Grumman	Federal Data Corporation	\$302M	
Northrop Grumman	Sterling's Federal Systems Group	\$150M	
Smiths Industries plc	TI Group plc	~\$2.8B	
Chevron Corporation	Texaco Inc	\$35B	
Rockwell Collins	Kaiser Aerospace & Electronics	\$300M	
General Electric	Honeywell	\$43B	
Chemring plc	Alliant Kilgore Flares Company LLC	\$20M	
General Dynamics	Primex Technologies	\$541M	
BF Goodrich	Raytheon Optical Systems	N/A	
SAFT-Alcatel	Hawker Eternacell	N/A	

Note: N/A indicates transaction value is not available for privately-held companies.

Figure 17.

Acquisition and Technology Program Decisions

While market forces often work to sustain credible competitive sources, a number of factors may operate to make firms less likely to remain in, or enter, defense-unique markets -- including limited demand and high market entry barriers. Today, for some critical and complex defense products, the number of competitive suppliers is, or will be, limited. Therefore, there

may be exceptional circumstances in which the Department needs to act to maintain future competition. Accordingly, DoD has taken steps to ensure that DoD Components consider the effects of their acquisition and budget plans on future competition.

In the last two years, the Department has put in place a series of policies directed specifically at enhancing DoD insight into industry and the competitive effects of DoD buying actions.

- Subcontractor Competition. In 1999 the Department issued a policy on subcontractor competition requiring program managers and contracting officers to increase insight into the subcontractor selection process and intervene, where appropriate.
- Anticompetitive Teaming. Also in 1999, DoD issued a policy challenging anti-competitive teaming arrangements. This policy required DoD program managers and contracting officers to scrutinize prime or subcontract teaming arrangements for their potential to inhibit competition.
- Future Competition for Defense Products. In July 2000, the Department put in place a new competition policy requiring that DoD consider the effects of its acquisition and technology strategy and budget plans on future competition. The policy requires: (1) improved visibility into cases where competition may be at risk (for example, where two or fewer competitors exist) and (2) a process to ensure that these risks -- which often transcend a single program and apply to an entire product market -- are assessed on a Department-wide basis.

Collectively, these policies are intended to increase DoD's focus on industry considerations in acquisition and technology program strategies, proactively. They also address the concerns of small and mid-size companies that increasingly feel squeezed out of competitions as large defense firms become more vertically integrated.

As a consequence of the July 2000 policy, the Deputies of Component Acquisition Executives will confer routinely with the Deputy Under Secretary of Defense (Industrial Affairs) to discuss areas where future competition may be limited and provide the Deputy Under Secretary of Defense (Industrial Affairs) with information on such areas based on reporting from program managers and other sources. This group will review areas that have been identified by acquisition program strategy reports, sole source Justifications and Authorizations, Integrated Product Teams, and more generally from industry sources. Where appropriate, the group will establish a DoD team to evaluate specific product or technology areas. Based on the analysis and findings of the team, the Under Secretary of Defense (Acquisition, Technology & Logistics) will decide on what, if any, DoD action is required to ensure future competition in the sector involved. The Under Secretary of Defense (Acquisition, Technology & Logistics) will direct any proposed changes in specific programs to the milestone decision authority for that program (for example, the need for a dual source in a critical subsystem area or the need for a next generation R&D project startup).

In addition to working with the Components, the Deputy Under Secretary of Defense (Industrial Affairs) will seek input on areas of competitive concern from industry and other interested parties. To assist DoD managers in understanding industry markets, the Department is making helpful (non-proprietary) market information available to the acquisition community on the deputate's web site. It also is publishing an informational Market Analysis Handbook with guidelines to help Component Acquisition Executives and their program managers identify important product and technology areas of potential competitive concern.

Internal Restructuring

Despite extensive consolidation and mergers, evidence suggests that U.S. defense firms still have opportunities to undertake *internal* restructuring (streamlining and disposal of assets not directly resulting from mergers and acquisitions) that reduce underutilized capacity, bring more efficient processes on line, and reduce net costs to DoD. Recent DoD-sponsored studies (as referenced in section 3.3) indicate, for example, that the aircraft, solid rocket motor, satellite, and shipbuilding industries have retained significant underutilized capacity (facilities, equipment, and manpower) -- at considerable expense to DoD and the taxpayers. Internal restructuring actions could allow defense firms to adopt commercial processes and increase the flexibility of their manufacturing lines. Such changes could produce not only efficiencies that reduce the costs of products to DoD, but also allow firms to better leverage opportunities for commercial and military product or business integration. The Department therefore encourages defense firms to take appropriate internal restructuring steps to rationalize assets and facilities and streamline operations, thereby lowering overhead costs.

However, there may be insufficient incentives for defense firms to pursue internal restructuring actions. While DoD policy allows firms to claim costs associated with *external* restructuring against defense contracts under specific conditions, cost savings gained through internal consolidations mostly are passed through to the DoD via "cost-plus" contracts. To address this issue, the Department is considering a proposed policy tool that would allow firms to retain a portion of internal restructuring savings, through adjustments to profit, for a period of years.

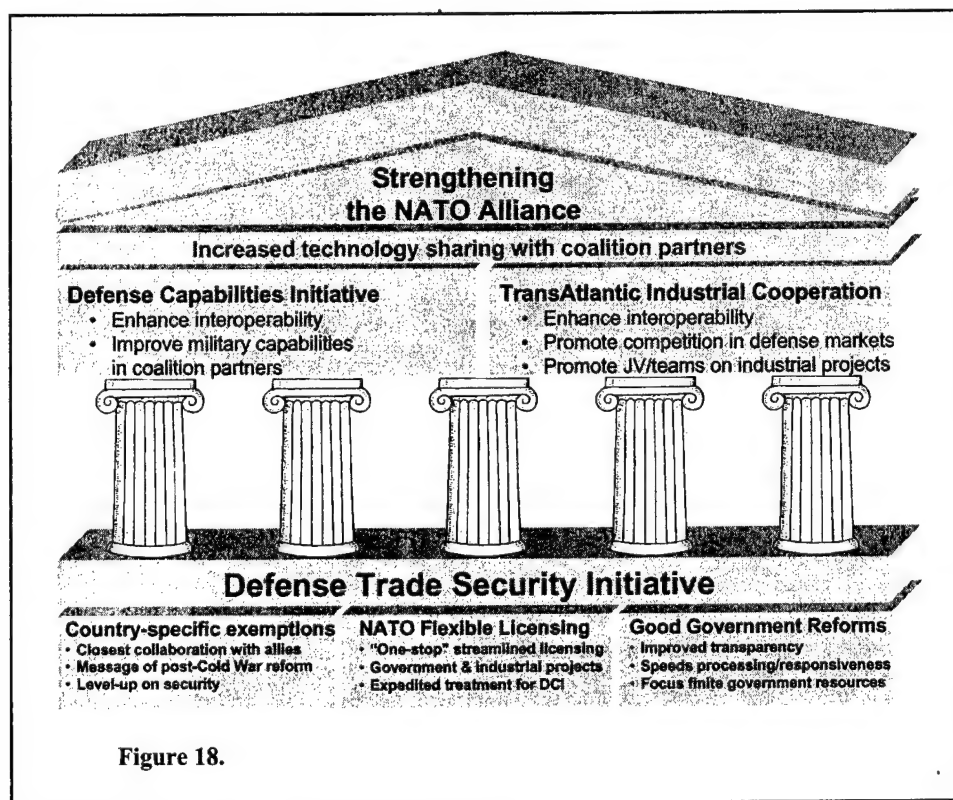
Maintaining National Security

Export Control Reform

Recent coalition operations, especially in Kosovo, revealed a need to improve NATO's ability to move forces quickly, support them for as long as necessary, provide them with the means to fulfil their missions within limits of acceptable risk, and enable them to communicate and operate smoothly and effectively with one another. In April 1999, the NATO Heads of State established the Defense Capabilities Initiative (DCI) to address these problems by focusing on five functional areas: (1) deployability and mobility; (2) sustainability and logistics; (3) effective engagement; (4) survivability of forces and infrastructure; and (5) command, control, and communications.

The United States intends to meet its commitments to the DCI, in part, by reforming its export control procedures. Although the United States is urging its allies to increase their military capabilities, the U.S. export control process often has impeded allied nation acquisition of U.S. systems and key components. The DoD and the State Department have established a mechanism to expedite the processing of export requests that support capabilities emphasized in the DCI.

Perhaps more importantly, however, the State Department in cooperation with DoD, has established the U.S. Defense Trade Security Initiative -- the first major post-Cold War revision of U.S. defense trade controls (Figure 18). The initiative, which has 17 discrete elements, has three major thrusts. All of these thrusts are designed to allow more technology sharing with coalition partners while maintaining and enhancing security vis-à-vis third parties.



- *New licensing exemptions to the International Trafficking in Arms Regulations are available for Treaty allies that have congruent policies in key areas and adopt and demonstrate export controls and technology security systems that are comparable in scope and effectiveness to those of the United States.* The exemptions would be limited to the export of unclassified defense items, technical data, and services to the foreign government and to companies that are identified as reliable by the U.S. Government in consultation with the foreign government. Additionally, the exemptions would be contingent upon establishment of appropriate international agreements on end use and retransfer of the items, data, or services and on close conformity of essential export

control principles. Because of our long history of cooperation with the United Kingdom and Australia, similar policies, and close industrial linkages, the State Department, with support from DoD, has begun negotiations on the exemption with these countries, first. The exemption, in effect, offers the greater degree of technology sharing with eligible allies in exchange for a "leveling up" of security with respect to third countries.

- *Creating flexible and broader licensing vehicles for use with NATO and other Treaty partners.* Appropriate vehicles would be available for a wide range of projects, including cooperative government-to-government programs, commercial sales, and private sector joint ventures and cooperative efforts.
- *Streamlining regulatory procedures and speeding up decision-making by utilizing computerization and filing applications electronically, with all the necessary data provided in real time.* (DoD has significantly reduced the time it takes to complete its internal license review -- down to about 20 days from over 46.)

U.S. - Australia Statement of Principles for Enhanced Cooperation in Matters of Defense Equipment and Industry

Consistent with its intent to foster closer industrial linkages with key allies, and following last year's Declaration of Principles with the U.K. Ministry of Defence (MoD), the DoD and Australian Department of Defence agreed to a Statement of Principles for Enhanced Cooperation in Matters of Defense Equipment and Industry in July 2000. The Statement of Principles addresses key areas of interest such as harmonization of military requirements and acquisition processes, R&D, facilitating the supply of defense articles and services to meet national defense requirements, technology transfer, export procedures, security of information, ownership and corporate governance, control of technical information, and promoting defense trade.

Foreign Investment in the United States

DoD is a member of the interagency Committee on Foreign Investment in the United States (CFIUS), chaired by the Treasury Department. DoD participates in that Committee by evaluating the national security aspects of proposed foreign acquisitions of U.S. defense contractors. DoD's overarching objectives are to: (1) facilitate the development of an integrated defense industrial base among U.S. allies and trading partners to increase interoperability in coalition warfare and reduce DoD acquisition costs; and (2) simultaneously, reduce the risks of unauthorized transfer of military and dual use technologies, inappropriate foreign control of U.S. defense firms, and unacceptable reduction in U.S.-located defense capabilities.

In the last year, DoD reviewed over 60 CFIUS cases. Several involved significant transactions that impacted the U.S. defense industrial base, including:

- BAE Systems (U.K.) acquisitions of Lockheed Martin's Aerospace Electronics and Control Systems businesses.
- The formation of multinational EADS, including U.S. subsidiaries of the EADS partners.

- Thomson-CSF (France) acquisition of Racal plc and its U.S. subsidiary Racal Communications, Inc.
- The merger of El-Op and its U.S.-located Kollsman Inc. subsidiary with Elbit Systems Ltd. (Israel).
- British Nuclear Fuels (U.K.) acquisition of ABB C-E Nuclear Power Inc.
- Smiths Industries (U.K.) acquisitions of Fairchild Defense Division of Orbital Sciences and the TI Group.

In some cases, the U.S. firms being acquired either possessed critical defense technologies under development or were otherwise important to the defense industrial and technology base. In these cases, DoD sought appropriate risk mitigation measures⁸ to eliminate national security concerns.

In addition, DoD has begun to engage foreign defense firms interested in fully participating in the U.S. market in a dialogue on the need for compliance with the Foreign Corrupt Practices Act and foreign laws established pursuant to the Organization for Economic Cooperation and Development's Convention on Combating Bribery of Foreign Public Officials in International Business Transactions (see Corrupt Practices subsection, below). DoD is seeking a "leveling up" of foreign firm conduct in this area because such practices are impediments to the development of democratic, rule-of-law based governance and market institutions, and impede fair trade in defense markets.

Priorities and Allocations

The United States has in place a Defense Priorities and Allocations System (DPAS) authorized by statute -- the Defense Production Act. The statute provides explicit authority for the preferential performance of defense contracts over commercial contracts. DoD has used the DPAS to secure timely delivery of military goods and services during crises (most recently, in Bosnia and Kosovo) and to minimize delays fielding new DoD systems during peacetime.

The statute also provides authority to provide the same preferential treatment for foreign nation defense orders in the United States when such treatment furthers U.S. national defense interests. To date, Canada (via a longstanding bilateral agreement) and the United Kingdom (via individual requests) have benefited significantly more than other allies have from this authority.

Among the consequences of globalization and industrial restructuring are the creation of multinational defense companies, possible loss of certain domestic industrial capabilities and capacities, and increasing acceptance of mutual defense interdependence. Reciprocal industrial priorities systems (also termed reciprocal security of supply systems) can provide increased

⁸ For example, special security agreements involving appointment of DoD-approved outside directors, visitation control reporting requirements, and technology control plans.

assurance that the Department's non-U.S. defense suppliers will be in a position to provide timely supplies in both emergency situations and during peacetime.

Reciprocity considerations have been a topic of discussion within NATO for some time. In February 2000, members of a NATO working group on "Assurance of Supply" developed a working paper "Agreement on Priorities and Allocations Systems Within the Alliance." This paper now is being coordinated formally. Of necessity, because of the many nations involved, the proposed agreement contained in the working paper is rather general, and the deliberative process is lengthy.

In lieu of focusing exclusively on negotiation and adoption of a NATO-wide agreement, formal *bilateral* agreements with key allies offer the United States an opportunity to establish stronger government-to-government agreements for reciprocal priorities support, more quickly. DoD representatives have had informal discussions about such bilateral agreements with United Kingdom, German, French, Italian, Dutch, Norwegian, and Swedish government representatives. Because of its close ties with the United States, a priorities agreement with the United Kingdom MoD appears to offer both more immediate potential benefits and a greater probability of success.

DoD and United Kingdom MoD representatives are engaged in preliminary discussions about the feasibility of negotiating a formal bilateral agreement that would commit each nation to: (1) establish and maintain a priorities system applicable both in peacetime and emergency/war; and (2) provide the other nation access to that system.

Corrupt Practices

The globalization of the defense industry has raised Department concerns regarding how U.S.-foreign defense joint ventures, or merged companies with foreign ownership, will operate in the international defense marketplace when it comes to issues related to compliance with the U.S. Foreign Corrupt Practices Act and similar foreign laws. Since enactment of the U.S. law in 1977, the United States has taken steps to build an international coalition to fight bribery and public corruption.

The Organization for Economic Cooperation and Development's (OECD) Convention on Combating Bribery of Foreign Public Officials in International Business Transactions, commonly known as the OECD Anti-Bribery Convention, was approved by all 29 OECD members and five non-member nations in December 1997 and entered into force in February 1999.

The OECD Anti-Bribery Convention requires its parties to criminalize the bribery of foreign public officials in the conduct of international business. It also requires parties to apply "effective, proportionate and dissuasive criminal penalties" to those who bribe; establish liability of "legal person" or impose comparable civil sanctions or fines; make bribery a predicate offense for money laundering legislation; improve accounting procedures; prohibit off-the-books accounts; and provide mutual legal assistance and extradition in cases falling under the Convention.

The Convention is an important initiative because much is at stake. Between May 1994 and April 1999, bribes allegedly were used to influence the outcome of 294 international contract competitions. The contracts totaled \$145 billion. Half of the alleged bribes involved military procurement and about three-fourths of the cases involved allegations of bribery by companies based in countries belonging to the OECD.

Bribery is pervasive because it is effective. For the competitions referenced above, alleged bribe offerors won 90 percent of the contracts sought. Most often, bribers lose to other bribers seeking the same contract. U.S. companies are known to have competed for and lost 75 contracts worth \$23 billion for which foreign competitors allegedly offered bribes.

Until February 1999, most OECD countries did not have any laws to combat bribery and public corruption. The Anti-Bribery Convention marked a milestone for the United States in its push for new international agreements against corruption.

The Anti-Bribery Convention is especially important for the U.S. defense industry as the industry seeks to compete or conduct business in foreign markets. While the United States today has a technologically innovative and robust defense industry capable of competing with the best in the global marketplace, its success depends on the ability to compete on a level playing field. Corruption raises the costs and risks for doing business -- penalizing companies that play fair and seek to win contracts through the quality and price of their products and services. The OECD Anti-Bribery Convention will help level the playing field so that all defense companies may compete fairly in the global market place.

Accessing Commercial Industrial Capabilities

Since at least the end of World War II, the industrial base supporting the U.S. military has increasingly diverged from the industry that supplies the commercial and consumer sectors of the American economy. This divergence accelerated during the 1990s when the end of the Cold War forced the defense industrial base into large scale reduction and reorganization. Today, most DoD procurement and R&D funding flows through contractors that specialize in defense or through defense-specific and segregated divisions of larger corporations. While there are important historic reasons for this divide, significant advantages may be accrued through better use of the two sectors:

- Reduced costs to acquire and support weapon systems.
- Improved performance throughout the life cycle of a weapon system.
- Shortened development times.
- Improved reliability and maintainability.
- Improved support for the defense-relevant portion of the industrial base.

In addition, increased access to commercial industrial capabilities may allow better access to technological developments that are occurring in the commercial world and may improve competition for military contracts. For DoD, the RAND Corporation is identifying the key barriers to increasing access to commercial industrial capabilities. In 2001, RAND will analyze each barrier using a case study methodology. DoD will use the results of this activity to improve DoD policies, improve the way DoD implements existing policies, and develop regulations or propose legislation to mitigate the impact of the barriers.

Niche Product Management

DoD procures a wide range of products and services to meet its national defense responsibilities. Security of supply of defense products, subsystems, components, and materials is critical to U.S. national security. Sometimes these products, subsystems, components, or materials are unique to defense applications, are procured in small quantities, must comply with varied specifications, and are technologically sophisticated or difficult to produce. In some cases, niche products are spin-off variants of commercial products with a large industrial base. In other cases, the product has no commercial analogue, or the commercial market has evolved away from a defense "legacy" need. Supply of DoD unique "niche" products tends to be tenuous.

If competitive free markets for goods and services are operating efficiently, producing firms charge a market clearing price that allows them to recapitalize their operations and secure profits necessary to yield a rate of return required by investors. A sampling of niche product areas reveals that they tend toward market failure; suppliers often are unable to charge or command a market clearing price for their goods. The character of this dysfunction is unique to each product area, sometimes due to information asymmetry or excessive technical or demand risk, but in every situation, the business model is difficult to implement with success. The "business case" is weak, driving productive capacity away from the desired market.

The preferred method of dealing with product procurement is holistic: allow the market to adjust to changes in demand without exogenous perturbation. Practically, this translates to charging the prime contractors with total system performance responsibility to deliver finished defense weapon systems that meet all specifications. Specifically, prime contractors (and their major subcontractors) must price into their bids the costs of subsystem and component development, test, and production, or face penalties for not meeting cost, schedule, or performance requirements. History shows that this market mechanism does not always work effectively. Such cases, when product supply disruption threatens defense operations and readiness or when the market failure is very clear, suggest some form of DoD action may be appropriate.

DoD actions can take many forms. Among them are direct capital investment in select company operations to secure capacity and capability, aggregation of demand to achieve productive scale economies, simplification of product specifications to lower production costs or leverage commercial processes, and direct subsidies to contractors to compensate for pricing misjudgments. These actions, however simple in theory, often are difficult to implement because they involve brokering consensus among many procuring agents, relinquishing some control

over product development and procurement, and ultimately developing a *collective* solution. In addition to continuing to target investments in key technology areas and continual monitoring of industrial capabilities, the Department's methods of oversight, analysis and management to this point have been via executive agents and cross-service working groups. Summarized below are the activities in three such product areas. The DoD approach to niche markets is an evolving one.

Microwave Power Tubes

Microwave power tubes are used to generate and amplify microwave energy -- a form of electromagnetic radiation. DoD uses microwave power tubes such as traveling wave tubes, klystrons, and crossed field amplifiers in land, sea, air and space applications. More the 270 different types of DoD radar, electronic warfare and telecommunications systems employ over 180,000 microwave power tubes with a total value of \$2.8 billion. As DoD deploys new systems and upgrades existing microwave power tube-based systems, the number of microwave power tubes in DoD applications will continue to increase for the next five years. DoD will continue to require affordable, high performance microwave tubes into the foreseeable future.

During the May 2000 International Microwave Power Tube Conference, U.S. industry representatives reported total annual 1999 sales of \$260 million. Even with the growth of the specialized commercial satellite communication market, over 85 percent of U.S. industry sales are for DoD applications. The U.S. microwave power tube industry is dominated by and dependent on DoD sales.

In 1997, DoD designated the Navy as its Executive Agent to: (1) identify and maintain consolidated DoD microwave power tube acquisition requirements and R&D plans; (2) monitor the major domestic microwave power tube manufacturers and key component and material suppliers; and (3) facilitate coordination among the Services and other U.S. government agencies that use microwave tubes.

In 2000, the Executive Agent, in cooperation with the other Military Departments:

- Completed the Tri-Service Manufacturing Technology Vacuum Electronics program, which sought to support and sustain affordable U.S. sources for millimeter wave and broad band products.
- Continued the Office of Naval Research/Naval Research Laboratory investment of category 6.2 science and technology in vacuum electronics. Investments focus on developing: (1) innovative device concepts; (2) advanced computer models and simulations; and (3) enhanced material science technologies, both for advanced system concepts and for upgrades to deployed DoD systems.
- Participated in the Office of Naval Research-led DoD balanced investment study of vacuum electronics and solid state R&D requirements in response to Congressional direction in the FY2000 and FY2001 Defense Authorization Acts.

- Initiated a Defense Production Act (Title III) project to increase the availability of critical materials used in the production of microwave power tubes. Initial efforts will address helix and filament wire and cathodes. Based on a model for technology transition established under the Tri-Service Manufacturing Technology project, the Navy will accomplish the project via an interactive consortia of material suppliers and U.S. microwave power tube industry representatives.
- Consulted with industry representatives to develop an alternate source of silicon carbide-loaded beryllium oxide ceramics in order to meet ongoing production demands.
- Continued efforts of the Air Force Research Laboratory Advanced Research Project in Innovative Vacuum Electronics Research to conduct advanced research in vacuum electronics and produce graduate engineers with advanced degrees and excellent design experience when they enter the workforce.
- Participated in the International Microwave Power Tube Conference (with over 400 industry and government personnel) to discuss R&D issues applicable to new microwave power tube applications and desired performance improvements of current systems.
- Increased DoD and industry interaction on microwave power tube acquisition, production, and operational performance in DoD systems by planning a Washington DC Microwave Power Tube Workshop for August 2001.

Additionally, the Executive Agent, on behalf of the DoD, is monitoring and/or addressing several areas of concern:

- With the continuing tightening of safe exposure requirements for beryllium, DoD desires the development of an environmentally acceptable material to replace the beryllium oxide-based lossy ceramics used in over 16 strategic and tactical DoD systems. Initial efforts have been funded under the Navy's Small Business Innovative Research program, but long term funding to fully characterize and integrate the new material into the designs has yet to be identified. The Executive Agent is working with the affected system program offices to alleviate this shortfall.
- The 1997 Microwave Power Tube Industrial Base study recommended that the Department's microwave power tube R&D investments be maintained at about \$18 million per year. FY2000 Navy 6.2 vacuum electronics funding (the only such funding in the DoD) was limited to \$10 million and the FY2001 funding is \$7.5 million.
- As is the case in many predominantly DoD industrial segments, microwave power tube manufacturers have underutilized facility capacity and are concerned that continued availability of technical personnel may be impacted by explosive growth in the civil Internet, telecommunications, and high technology sectors. The Executive Agent and industry representatives are monitoring this concern and are working with the acquisition communities to improve facility utilization.

Radiation Hardened Microelectronics

DoD satellite and missile systems have unique radiation and electrical requirements that commercial systems need not meet. These defense systems are designed to survive extreme weapons-produced nuclear radiation environments (for example, neutrons, radiation dose rate, high total radiation dose) and ensure the nation's survival through uninterrupted autonomous operation of defense unique functions (threat detection, tracking, engagement, and assured command and control communications). In order to meet these unique requirements many defense systems utilize specially manufactured microelectronic devices. Commercial off-the-shelf-electronics are not designed to survive in these environments and each new generation of commercial electronics displays greater radiation vulnerabilities. Radiation *hardened* microelectronics are designed to withstand the deleterious effects of extremely high radiation levels that might occur as the result of a nuclear weapon burst or long-term radiation exposure. Conversely, radiation *tolerant* microelectronics are able to withstand the effects of lower levels of naturally occurring radiation, and will fail or malfunction if subjected to nuclear weapon burst radiation levels. In 1996, the Department conducted an assessment to determine if there are and will be sufficient industrial capabilities -- technology, engineering, manufacturing, and test -- to meet projected DoD radiation hardened microcircuit requirements. The results of the assessment were summarized in the February 1997 *Annual Industrial Capabilities Report to Congress*.

In May 1997, the Under Secretary of Defense (Acquisition, Technology & Logistics) requested that DoD:

- Implement a radiation hardened microcircuit R&D investment strategy (at between \$60 million and \$70 million, annually) to focus required technology and new product development activities.
- Establish a corporate management approach, the Radiation Hardened Oversight Council (RHOC), to oversee implementation.

In June 1999, the Department established the Radiation Hardened Electronics Oversight Council (RHOC) to ensure the continued capability and availability of radiation hardened electronics to meet U.S. security needs. The RHOC has heightened senior Department leadership awareness of this critical niche product area and resulted in a coordinated DoD effort to solve problems. Interaction with the Joint Staff resolved issues associated with requirements for hardening satellites, and the Defense Threat Reduction Agency expedited the issuance of new guidelines for system radiation hardening calculations. RHOC working groups have confirmed that DoD needs this technology, developed a technology roadmap to meet these needs, and determined the funding levels needed to meet technology milestones that support engineering freeze dates for DoD systems.

The current industrial environment continues to be unsettled:

- The two principal suppliers of digital radiation hardened microcircuits remain committed to advancing radiation hardened digital electronics to meet DoD's unique needs.

However, low levels of DoD R&D investment, delays in volume purchases by major DoD programs (Space-Based InfraRed System [SBIRS] High, SBIRS Low, and Advanced Extremely High Frequency), and the failure of anticipated commercial space purchases to materialize may result in a business case that is insufficient to maintain corporate support for the radiation hardened microcircuits infrastructure. One or both of these suppliers could exit the market.

- Both manufacturers of analog radiation hardened microcircuits have indicated that their main focus is commercial electronics. Due to a lack of DoD R&D investment and purchases, these vendors are no longer designing or producing unique integrated circuits for DoD. However, they may modify a commercial component to meet DoD needs.

Flat Panel Displays

Flat panel displays (FPDs) are almost universally replacing cathode ray tubes (CRTs) in ground, air, and sea defense systems. FPDs are more reliable than CRTs; they exhibit much greater time between failures. Additionally, they weigh less, take up less space, use less power, and have many superior viewing characteristics, such as contrast and resolution. However, DoD FPD procurement for many platforms (including the AH-64 Longbow Apache, the F-18 and F-16 fighters, and the M2A3 Bradley Fighting Vehicle) has been problematic due in part to limited industrial capabilities.

Large targeted DoD investments during the mid 1990s in industrial capacity for domestic thin film transistor (TFT) glass lithography and display assembly and "ruggedization" have not produced stable or cost effective supply for primes and their major integrators. Rather, costs have escalated and supply diminished. As was the case in 1998, calendar year 2000 saw a sole-source provider of Active Matrix Liquid Crystal Displays (AMLCDs) for demanding cockpit and ground vehicle applications leave the military business (in 1998, the company failed outright), and closure of the only U.S. AMLCD glass foundry. Inefficient processes and yields resulted in cost increases that drove prime customers to look elsewhere for displays. Specifically, cockpit integrators have gone to offshore glass and display providers, or a new onshore firm using TFT glass from an Asian company.

Essentially, the strategy to fully capitalize a unique domestic military industrial infrastructure to supply platform prime contractors and system integrators with display-ready glass has not proved effective. In part this is because of the intrinsic nature of AMLCD glass production, in which process yields, and thus cost and quality, are driven largely by volume. The military market is not large enough to be viable, at least not at the price levels that prime contractors and their major subsystem integrators are willing to sustain. The answer seems to lie in leveraging the over \$5 billion of capital investment going into commercial AMLCD production. The commercial flat panel display marketplace, driven largely by extraordinary growth in demand for cellular phones, computer monitors, flat panel televisions, and personal digital devices, currently exceeds \$25 billion per year and is growing at about 25 percent per year. A successful business model in this industrial environment would leverage high volume facilities capitalized to supply broader consumer markets to meet military unique needs. This

requires defense firms to establish effective relationships with glass sources and display manufacturers to ensure integrity of supply chains.

The Department has monitored the industry closely throughout the past year, engaging prime and sub-tier contractors as well as the military services to characterize and resolve supply challenges. The Department continues to actively monitor and assess the short-term supply risk associated with contract migration to a new supplier that is ramping up operations and second source development. While short-term supply is tenuous, the long-term outlook for the industry is much better. Prime contractors and system integrators are tapping new and proliferating sources of AMLCD glass, and alternative technologies that stand to replace AMLCD technology in the future are being developed and evaluated for DoD applications.

Related DoD Programs

DoD continues to employ programs designed to develop or improve defense-critical industrial and technological capabilities; and to identify, adapt and leverage predominantly commercial and dual use capabilities and products for defense applications.

- *DoD's Manufacturing Technology Program* supports the implementation of defense-critical manufacturing processes to improve affordability and facilitate the ultimate success of weapon system programs.
- DoD can use the authorities of *Title III of the Defense Production Act* to provide domestic firms with financial incentives to establish, modernize, or expand domestic production capability and capacity for technology items, components, and industrial resources essential for national defense.
- DoD uses its *Technology Transfer Program* to monitor DoD research and development activities, identify those technological advances that have potential for non-defense commercial applications, and facilitate the transfer of such technological advances to the private sector.
- DoD's *Commercial Operations and Support Savings Initiative* adapts and inserts commercial items into fielded defense systems to reduce operations and support costs.
- Within the *Dual Use Science & Technology Program*, DoD jointly funds research projects with industry that develop dual use technology solutions for DoD problems.
- The Department co-chairs the *North American Technology and Industrial Base Organization* (NATIBO). NATIBO is chartered to identify and analyze key technology and industrial sectors that are critical to defense, assess the viability of these sectors, identify issues and barriers related to sector viability, and develop strategies to enhance and sustain the health of the marketplace.

Sections 5.1 and 5.2 contain summaries of 2000 activities associated with these programs.

The Department also conducts industrial capabilities assessments to profile industrial or technological capabilities associated with an industrial sector, subsector, or commodity important to DoD. DoD industrial assessments: (1) identify the key industrial and technological capabilities required to compete effectively in a particular market area; (2) profile current and potential suppliers that possess those capabilities; and (3) determine the extent to which demand estimates might influence the continued availability of those capabilities. Section 4 summarizes industrial capabilities assessments, decisions, and actions completed during 2000.

3.5 New DoD Policies

In 2000, the Department augmented existing industrial capabilities-related guidance by issuing new guidance to facilitate future competition for defense products and comply with Congressional direction to protect essential conventional ammunition industrial and technological capabilities.

Future Competition for Defense Products

As discussed in the "Maintaining Future Competition" portion of section 3.4, there may be exceptional circumstances in which the Department needs to consider whether there are steps that can and should be taken to help maintain future competition.

In July 2000, the Under Secretary of Defense (Acquisition, Technology & Logistics) issued a policy memorandum requiring that DoD Components consider the effects of their acquisition plans on future competition. Specifically, Components and Program Managers will consider several steps during acquisition planning:

- During cost/performance trade discussions, identify and evaluate changes in program requirements that would facilitate the use of a larger commercial or common product market.
- Identify areas where competition is limited, for more senior level visibility and evaluation.
- Outline options to increase competition for specific product or technology areas within an individual program where competition is limited.

To help carry out this policy, the Deputies of Component Acquisition Executives will meet routinely with the Deputy Under Secretary of Defense (Industrial Affairs) to discuss areas where future competition may be limited; and to develop recommendations for DoD-wide action, as appropriate. On a case-by-case basis, the Under Secretary of Defense (Acquisition, Logistics & Technology) will decide whether any DoD action would be appropriate to help maintain future competition in the specific product or technology area.

The Department is institutionalizing this policy in DoD Regulation 5000.2-R, "Mandatory Procedures for Major Defense Acquisition Programs and Major Automated Information System Acquisition Programs."

Conventional Ammunition

Section 806 of the Strom Thurmond National Defense Authorization Act for FY1999 required that the official in the Department of the Army designated as the Single Manager for Conventional Ammunition shall have the authority to, and shall restrict, conventional ammunition procurements to domestic sources when necessary to protect national security. Accompanying report language (House Report No. 105-736 at page 690) specifies that "This provision supersedes existing guidance issued by the DoD as it relates to the procurement of ammunition from domestic sources. The conferees direct the Department of the Army to issue new guidance to replace the DoD guidance superseded by this provision."

Accordingly, in May 2000, the Army issued guidance that described how it will: (1) review planned Army and other Military Department conventional ammunition procurements and (2) ensure such procurements are restricted to domestic sources when necessary to protect essential industrial and technological capabilities.

In November 2000, DoD issued conforming Department guidance requiring that the Military Departments submit to the Army's Deputy for Ammunition for review and concurrence: (1) acquisition plans and strategies for all procurements of conventional ammunition; and (2) new procurements of conventional ammunition covered by previously approved acquisition plans. The Deputy for Ammunition will review the procurement approach to determine if the plan or strategy is consistent with retaining needed national technology and industrial base capabilities. If the Deputy for Ammunition and the Military Department cannot agree on the appropriate acquisition approach, the Assistant Secretary of the Army (Acquisition, Logistics & Technology) will make the final determination.

4. Assessments, Decisions, and Actions

4.1 Introduction

The Department periodically conducts assessments to identify and evaluate those industrial and technological capabilities needed to meet current and future defense requirements. It then uses the results of these assessments to make informed budget, acquisition, and logistics decisions.

"DoD-wide" industrial assessments evaluate and address changes in key component and material providers that supply many programs, and affect competition, innovation, and product availability. The Department also periodically conducts domestic source restriction assessments to determine if foreign product restrictions contained in the Defense Federal Acquisition Regulation Supplement (DFARS) that were imposed by a DoD policy decision, not by statute, still are required for national security reasons. Additionally, DoD Components frequently conduct their own analyses when: (1) there is an indication that industrial or technological capabilities associated with an industrial sector, subsector, or commodity important to a single DoD Component could be lost; or (2) it is necessary to provide industrial capabilities information to help make specific programmatic decisions. These assessments generally are conducted, reviewed, and acted upon internally within the DoD Components. Additionally, the Defense Contract Management Agency's Industrial Analysis Center (IAC) supports DoD corporate and Component industrial assessments by utilizing its broad knowledge across industrial sectors and its on-site presence in many contractor industrial facilities.

4.2 DoD-Wide

Analysis of the Financial Health of the U.S. Defense Industry (May 2000)

Problems on specific programs, reduced earnings estimates, and significant declines in the price of certain U.S. defense stocks led some observers to question the overall health, structure, and competitiveness of the U.S. defense industry. In response to these questions, the Office of the Deputy Under Secretary of Defense (Industrial Affairs) contracted with JSA Partners, Inc. to evaluate the financial performance and stock market valuation of major U.S. defense firms. From a list of the top 100 worldwide defense contractors (based on 1998 revenues), JSA Partners excluded foreign firms, privately owned firms, and those firms for which aerospace/defense revenues were less than 25 percent of total revenues; 21 publicly traded U.S. defense firms remained. JSA Partners then added nine more important system, subsystem, component, and services firms -- bringing to 30 the number of U.S. defense firms to be analyzed. JSA Partners found that:

- Several factors enabled the aerospace and defense industry to achieve relatively superior performance in the mid 1990s.

- In the period 1994-1996, earnings before interest, taxes, depreciation, and amortization (EBITDA) margins were 10-12 percent, up from historical levels of 7-9 percent.
 - Free cash flow (EBITDA minus capital expenditures minus taxes) increased significantly, driven by cost reductions from industry downsizing, decreases in capital investments, and short term gains from consolidation mergers and acquisitions,
 - Wall Street rewarded aerospace/defense firms for the improved free cash flow with very high stock price-to-earnings multiples.
- A return to historical profit margins and operational problems at Lockheed Martin, Raytheon, and Boeing Aerospace had a disproportionately negative impact on the stock price of many companies in this sector.
 - They were unable to maintain the high levels of free cash flow of the mid 1990s and stock prices declined significantly.
 - Boeing's difficulties in integrating McDonnell Douglas' commercial aircraft activities led to a 1997 loss that damaged Boeing's stock price -- which has not recovered despite improving performance.
 - Boeing's difficulties also negatively impacted the stock price of many of its suppliers, even though these suppliers did not experience similar profit declines.
 - Multi-industry companies with large aerospace assets (for example, United Technologies, Honeywell, and Textron) have outperformed the aerospace/defense stock index significantly, and also the Standard & Poor's industrials index.
 - In general, multi-industry companies extract better performance from their aerospace/defense segments than the other parts of their business. They also achieve better operating performance than dedicated aerospace/defense companies.
 - In general, however, the aerospace/defense sector has not kept pace with an overall improvement in profit margins within other technology industry sectors, and this has put the defense industry at a disadvantage in attracting investment capital and qualified people.

DoD is considering what steps it should take to improve its acquisition and technology procurement system to enable aerospace/defense firms to grow their business, improve profit margins, and attract capable scientists and engineers.

Space Industrial Base Study (December 2000)

New requirements, industrial acquisitions and mergers, and recent space system contract awards are changing the space industry. The consulting firm of Booz Allen & Hamilton conducted this study for the Under Secretary of Defense (Acquisition, Technology & Logistics) and the Director, National Reconnaissance Office. The study was designed to determine if: (1) the current and projected U.S. space industrial base is capable of meeting national security

requirements for the next 15 years; and (2) there will be adequate competition within the industry over that same period of time. The assessment concluded that:

- The prime contractor industrial base is sufficient to support near- and mid-term national security space demand. The long-term outlook is less clear as overcapacity could cause some prime contractors to exit the business before 2015.
- The subcontractor industrial base generally is sufficient to support near- and mid-term national security space demand.
 - Component areas in which industrial capabilities are problematic are radiation hardened electronics, rubidium atomic clocks, lightweight optics, high performance space-based radar payloads, high frequency/high power/high bandwidth travelling wave tubes, and large control moment gyroscopes.
 - For the most part, the program managers with missions most directly affected are aware of these problem areas and are addressing component-specific concerns for the life of their programs.
 - However, there does not appear to be a process for preventing a recurrence of critical bottlenecks between current and follow-on programs.
- Significant excess capacity will thin the ranks of satellite and launch vehicle manufacturers.
- The combination of shorter production cycles and longer spacecraft lifetimes will force satellite manufacturers to balance the requirements of national security programs against the demands of other customers. For programs requiring medium and small satellites, manufacturers can be expected to treat DoD programs as marginal buyers who are fitted in between mainline commercial and civil sector customers.
- Competitive discipline can be maintained through access to global space markets.
 - While the United States maintains a technical lead in many satellite requirements, less capable, non-U.S. substitutes are available for the commercial sector and for other nations.
 - Foreign sales are an important component of the financial viability of the U.S. space industrial base.
 - Global competition may result in greater efficiencies, lowering the government's costs for satellites and launch services.
 - Technology transfer policies that retard the ability of U.S. firms to compete in global space markets are reducing the opportunities for near-term economies of scale in satellite manufacturing. Such policies also could accelerate the exit of subtier U.S. suppliers with the unintended consequence of increasing U.S. dependence on foreign component suppliers in the mid- and long-terms.
- The national security community is not investing sufficient resources to sustain innovation for future space systems. Although civil and intelligence community

investments in advanced missions can foster some key space technologies, reductions in DoD's space S&T funding reduce the range of options for designers of future navigation, surveillance, and survivable communications payloads.

- The U.S. base of human capital and knowledge is declining at an accelerating rate.
 - In some areas the industry is unable to provide compensation comparable to other high technology careers.
 - While the U.S. space industry historically attracted and retained its workforce by offering unique technical challenges, those opportunities are diminishing as funding declines for advanced development projects.

DoD already is taking steps to streamline export and technology transfer policies appropriately, leverage commercial market capabilities, and consider the effects of its acquisition strategies on future competitions. DoD also is considering steps to improve its research and development program by strengthening funding. Finally, DoD is considering steps to facilitate the hiring and retention of capable scientists and engineers by adjusting compensation guidance to clarify that defense firms are permitted to pay competitive salaries, and providing technical challenges in the form of innovative research and development.

Polyacrylonitrile Domestic Source Restriction Assessment (May 2000)

PAN-based carbon fibers are used extensively in military composite structures applications where signature reduction, light weight, high tensile strength and high tensile modulus (stiffness) are important. PAN carbon fibers are combined with plastic resins to produce a composite *prepreg*. Composite prepregs (in tape or fabric form) then are fabricated into a composite structure such as a wing, tail fin, or missile motor case.

Both the Congress and the Department have established restrictions on the use of foreign products in defense systems. (DoD's foreign product restrictions are imposed by administrative action, not by statute.) During the Cold War, these restrictions generally were designed to preserve a domestic mobilization base -- to maintain the industrial capability required to rapidly produce the defense materiel needed to respond to an attack by the Soviet Union. Today, DoD bases its wartime planning needs on a requirement to fight and win (primarily from existing resources, including already stockpiled materiel) two nearly simultaneous major theater wars.

In 1996, the Department examined all foreign product restrictions contained in the DFARS that were imposed as a result of a DoD policy decision. (The Department did not formally evaluate foreign product restrictions imposed by statute.) For each restriction, the Department carefully evaluated if there were national security reasons or supplier reliability, cost, or quality reasons for retaining the restriction. During these deliberations, the Department decided to retain a foreign product restriction for polyacrylonitrile (PAN) carbon fiber for the present, but committed to review the restriction again after three years.

In May 1999, the Department began gathering relevant information from the Military Departments, the Defense Logistics Agency, organizations within the Office of the Secretary of

Defense, U.S. PAN carbon fiber suppliers, and the Aerospace Industries Association to determine if the restriction should be retained. The Department evaluated DoD applications for PAN carbon fiber, key domestic and foreign suppliers, supply and demand market information, potential impacts on DoD and key suppliers, and potential national security issues.

In May 2000, based on the evaluation, DoD decided to eliminate the restriction over a five-year period to allow domestic suppliers time to improve their capabilities and to mitigate viability concerns during the current period of worldwide production over-capacity. Specifically, DoD will maintain the restriction in full in years one through three, retain the restriction only for DoD programs that have not yet entered into the engineering and manufacturing development acquisition phase in years four and five, and eliminate the restriction in its entirety thereafter.

This approach minimizes short-term risks to both DoD and the current domestic suppliers. It also allows for a gradual introduction of competition that will encourage innovation and emphasize affordability. This action is consistent with DoD's interest in promoting vigorous competition in defense markets while also ensuring that industrial capabilities essential to national defense are preserved. The Department implemented its decision via a change to the DFARS.

4.3 Army

Countermines Sector Study (January 2000)

The Army performed this assessment to identify risk areas associated with the industrial and technological capabilities required to produce countermines systems. The Army concluded that the countermines industrial sector has sufficient industrial and technological capabilities to support Army needs. The countermines industry is financially viable, there are multiple sources for key components, and reliable alternative sources also are available.

155mm Modular Artillery Charge System Procurement (January 2000)

The Army performed this assessment to identify risk areas associated with the industrial and technological capabilities required to produce the M231 Propelling Charge for Army and Marine Corps 155mm howitzers. The Army determined there was a risk and decided to: (1) award a sole source contract to Armtec Defense Products Co. (\$14.8M) for combustible cases; (2) award a sole source multi-year contract to Primex Technologies, Inc. for ball powder (\$164K); (3) limit competition of propellant to the current producers (Alliant Techsystems and Expro Chemicals) and award a contract to Alliant Techsystems (\$8M); and (4) restrict procurement of load, assemble, and pack services to North America and award a contract to HITECH, Inc. (\$16M).⁹

⁹ In accordance with the requirements of section 806 of the Strom Thurmond National Defense Authorization Act for FY1999, the Army must restrict conventional ammunition procurements to domestic sources when necessary to protect national security.

This strategy also mitigated internal vertical integration issues and resulted in affordable quality products. The Army used the resulting savings and those achieved from a related manufacturing technology project to increase purchase quantities from 363,000 to 455,000 charges (a 25 percent increase). Total value of the contracts was \$39 million.

Theater High Altitude Air Defense Weapon System (February 2000)

The Army performed this assessment to identify risk areas associated with producing the Theater High Altitude Air Defense (THAAD) system. The Army concluded that risks associated with industrial and technological capabilities are low - medium, primarily due to an emphasis on commercial off-the-shelf and military off-the-shelf components. The Army is taking action to develop a domestic source for the ultra high modulus PAN carbon fiber used in the bulkheads of the Divert Attitude Control System.

Comanche Weapon System (March 2000)

The Army performed this assessment to identify risk areas associated with the industrial and technological capabilities required to produce the Comanche. The Army concluded that both prime integrators (Boeing and Sikorsky) have the requisite industrial, technological, and financial capabilities required to support the Comanche Program. Each contractor has a strong business base, including a significant portion of the total world market (24.3 percent, 20.5 percent, respectively). Current and planned U.S. major military programs with which the contractors are involved (AH-64D, V-22, CH-47F, UH-60+ and RAH-66) have strong backing by the Services and Congress.

Impact on Tactical Missiles from Industrial Consolidations (June 2000)

The Army performed this assessment to identify risk areas associated with the industrial and technological capabilities required to produce tactical missiles at reasonable costs. Contractors have consolidated many tactical missile programs to centralized geographic locations. Contractor overhead rates have increased as they relocated programs and consolidated functional organizations. In addition to issues associated with moving equipment, some intellectual resources also have been impacted. The most significant loss to tactical missile programs occurred when key contractor software experts refused relocation offers. As a result, the contractors experienced a reduction in their ability to support systems, especially, difficulties meeting schedule, cost, and performance requirements for product improvement programs.

The Army is working with the Defense Contract Audit Agency, the Defense Contract Management Agency, and industry to minimize future rate increases and to ensure the industry changes result in a more efficient and cost effective industrial base. For example, contractors have aggressively recruited college graduates with strong software credentials and captured and archived program corporate knowledge. Each affected Army program office is intensively managing risk mitigation, tracking progress, and addressing the issues during program and executive reviews.

Tank Ammunition Line of the Future (August 2000)

The Army performed this assessment to identify risk areas associated with the industrial and technological capabilities required to produce tank ammunition. Based on a review of tank load assemble and pack operations at Iowa Army Ammunition Plant, the Army awarded a \$5.4 million production base support contract to American Ordnance (the Iowa Army Ammunition Plant operating contractor) to improve efficiencies by utilizing lean manufacturing concepts and incorporating the latest automation equipment. When completed, line capacity will increase from 900 rounds per shift to 1200 rounds per shift.

Medium Caliber, 20mm Procurement (August 2000)

This assessment was designed to determine if the Army should use other than full and open competition to award contracts for 20mm tactical ammunition. Primarily, the Air Force and Navy use the 20mm cartridges for chain gun applications. To avoid risk, the Army decided that it should restrict the procurement to domestic sources and awarded contracts to Alliant Techsystems and Primex Technologies, totaling approximately \$16 million.

Ordnance Activities Rightsizing Study Phase 1 (August 2000)

RAND conducted this study for the Army. The study was designed to evaluate the feasibility of rightsizing Watervliet and Rock Island Arsenals to consolidate operations with the ultimate objective of reducing unutilized capacity at each facility to less than 25 percent. Phase 1 was limited in scope. It addressed only equipment and space footprint reductions to improve efficiencies at the arsenals; and assumed existing missions and currently projected workloads would continue. That is, the study did not consider arsenal consolidation and/or closure.

The study concluded that unutilized capacity at the arsenals cannot be decreased to levels approaching the 25 percent objective without dramatic increases in peacetime workload or reengineering of the manufacturing processes to eliminate equipment.

The study further concluded that although significant space and equipment reductions are possible, such reductions would save little money because 86 percent of arsenal costs are associated with personnel, purchased services, and materiel. Only a few civilian positions are associated with the floor space and equipment to be divested; most of the positions are associated with actual production and base support. Projected total savings from space and equipment reductions average about \$1 million per year and implementation costs are projected to total about \$11 million. With a potential to lease evacuated space to private firms, the Army anticipates the reductions could achieve a positive return within 11 years.

As a result of the study, the Army intends to pursue significant equipment and space reductions at the arsenals (43 percent of the equipment and 31 percent of the space at Watervliet; and 22 percent of the equipment and 29 percent of the space at Rock Island).

Crusader Industrial Base Assessment (October 2000)

The Army conducted this assessment to determine if the industrial and technological capabilities required for the Crusader program likely would be available when needed. The Army concluded that the existing tracked vehicle industrial base has the capabilities and capacities required to develop, produce, maintain, and support critical components of the Crusader system. The contractor has demonstrated prototype vehicle production capability; and manufacturing processes are considered adequate.

However, with actual production not scheduled to begin until 2006, the Army will continue to monitor workloads and financial capabilities within the supplier base to determine if consolidations, budget cuts, and uncertain Army requirements may impact industrial and technological capability availability. The most likely issue is not one of insufficient capacity or capability but one of potentially insufficient workload to maintain capabilities at an optimum, cost competitive level. Concerns associated with key components such as hulls, gun tubes, transmissions, and armor may arise due to forecasted reduced workload at current manufacturers.

Family of Medium Tactical Vehicles (October 2000)

The Army conducted a market survey of leading truck engine manufacturers and concluded that the 2004 Environmental Protection Agency (EPA) standards pose a significant technical challenge that will have cost, schedule and performance impacts on the Family of Medium Tactical Vehicles (FMTV) program. The FMTV program utilizes an acquisition strategy based on assembling state-of-the-art commercial components. EPA requirements to reduce emissions from heavy-duty diesel engines will force commercial truck engine manufacturers to change engine technology and employ high efficiency emission control devices that are intolerant to sulfur. EPA testing (with DF2 fuel) has indicated that engines can meet the emission standards. However, the Army primarily uses JP8, a fuel with greater impurities (sulfur). Commercial truck engine manufacturers will be changing production processes to make the new engines and the Army may not be able to access commercial sources for engines that can meet military performance and interoperability requirements within DoD and with its allies. The Army likely will have to deviate from reliance on commercial standards in the procurement of new engines over the next few years.

Continuous Electronics Enhancement Program for Abrams Tank (October 2000)

In this assessment, the Army found that a number of the electronic components used in the M1A2 Abrams tank might not be available in the near future. The M1A2 Abrams Project Manager has instituted a Continuous Electronics Enhancement Program to mitigate the risk of electronic component obsolescence caused by rapid changes in technology and application (software) growth. Using this program, the Army will upgrade the tank electronics in approximately a five-year cycle by replacing old electronics (primarily electronic circuit boards) at the shop replaceable unit level. To date, the Army has partially funded this project.

Joint Service Nuclear, Chemical and Biological Defense Logistics Support Plan (April 2000)

This annual plan, prepared by the Joint Service Materiel Group, focuses on readiness and sustainment capabilities in the Nuclear, Chemical and Biological (NBC) Defense industrial sector. It defines the quantity of each item of NBC Defense equipment required to fight and win two Major Theater Wars (MTWs) and summarizes inventory quantities for that item. In this manner, the plan identifies shortages in fielded end items and consumables. The report also addresses the capability of the industrial base to offset any mismatches between inventories and requirements. This report is used to develop the Chemical and Biological Defense Program Annual Report to Congress. Significant findings include:

- Inventories for 12 fielded NBC Defense end items and 27 consumable items are below that projected to be necessary to fight and win two MTWs.
- NBC suppliers have limited capabilities to increase production during a conflict to offset inventory shortages.
- An additional \$946.9 million would be required to match inventory with projected combat requirements by FY2004.

The Soldier and Biological Chemical Command (SBCCOM) is considering options (for example, maintaining "warm" production lines and/or additional procurements) to mitigate identified shortfalls. Additionally, SBCCOM is taking steps to increase its total asset visibility of items in unit-level inventory.

NBC Defense Sector Contractor Assessment (June 2000)

The Defense Contract Management Agency's Industrial Analysis Center performed this study for the Army. This assessment is an update of one conducted originally in 1998. It will be updated annually hereafter. The assessment evaluated the health of the industrial base supporting NBC Defense by focusing on four major sub-sectors: (1) Contamination Avoidance; (2) Decontamination; (3) Collective Protection; and (4) Individual Protection. Although the assessment concluded that, overall, the NBC Defense subsectors have sufficient capabilities and projected business to be considered a low risk, there are some areas that require attention:

- The single manufacturer of radiation analysis and detection devices (radiacs) is rated a high financial risk.
- One of the five manufacturing firms of collective protection systems is rated as a high financial risk.
- Four of the six manufacturers of chemical protective overgarments are considered a moderate financial risk. The other two firms did not provide sufficient information to permit an analysis.

SBCCOM will consider alternative sources of radiacs and will monitor the current manufacturer. Additionally, SBCCOM will monitor the performance of the collective protection system and chemical protective overgarment producers that are rated financial risks, and consider alternate suppliers if necessary.

NBC Defense Industrial Base Economic Forecast 2000-2025 (May 2000)

The Defense Contract Management Agency's Industrial Analysis Center performed this study for the Army and will update it as needed. The study examined current and forecasted economic and industry data through the year 2025. Study findings and conclusions included:

- NBC Defense budgets are forecasted to increase slightly with significant cyclical variation.
- NBC Defense systems contractors are diverse, predominantly commercial firms where DoD has little market power.
- Despite positive financial and business demand forecasts, there may be further consolidation in the sector. Consolidation in the smaller firms and sub tier markets likely will be completed in the next few years.
- NBC Defense industries are growing, becoming more productive.
- Employment and capacity utilization are expected to remain near present levels. This stability means that NBC Defense contractors most likely will be able to meet contractual obligations and retain skills and capabilities through 2005 and beyond.

SBCCOM will continue to leverage the commercial market place to safeguard industrial capabilities and reduce costs whenever possible. However, specific market segments and contractors will require monitoring, especially to ensure that key labor skills are retained.

NBC Defense Program Annual Report to Congress (March 2000)

This annual report informs Congress of the status of the Joint Service NBC Defense Program and serves as a record of progress. It is both an assessment and a description of DoD plans to survive, fight, and win in an NBC contaminated environment. It includes an analysis of DoD's NBC Defense logistics posture (with an industrial base section), assesses the status of NBC Defense training and readiness within the Services, and provides information on NBC Defense research and development programs.

The report concluded that the NBC defense industrial base sector is supported primarily by small-to-medium sized firms. Firms making ordnance and ordnance accessories are an exception to the general finding that NBC Defense suppliers are diverse and commercially oriented. These firms are highly specialized and dependent on DoD business. SBCCOM is forming a joint integrated product team to identify and address industrial issues and make specific program recommendations as required to sustain capabilities.

Radio Frequency Communications Industrial Capability Assessment (October 2000)

The Army performed this assessment to identify risk areas associated with the industrial and technological capabilities required to produce tactical and other military radios. In general, the Army found large numbers of commercial producers that are capable of producing these products. With virtually an unlimited number of sources capable of meeting its requirements, the Army considers industrial capabilities required for radio communications to be low risk.

However, these commercial producers concentrate on commercial markets, presenting some problems for the Army. Commercial demand has resulted in component supply problems for lower tier military items. For example, the commercial cellular telephone and wireless electronics industry use enormous quantities of electrolytic capacitors, which also are key components in military radios and other military electronics systems. This commercial demand has led to shortages and increased procurement lead times for many military subsystems. If this trend continues, the Army may have to consider special actions to maintain projected fielding schedules for future systems.

Bearing Study 2000 (November 2000)

The Army, Department of Commerce, and Defense Logistics Agency performed this study jointly to assess industry's ability to meet the Army's requirements for anti-friction bearings for helicopters, missiles, and tracked combat vehicles. The study addressed three broad areas: (1) the impact of global competition, (2) the ability of system integrators to access needed anti-friction bearings, and (3) the domestic industrial base.

Competition is global and intense. U.S.-owned companies account for a declining share of world bearing production. Firms located in the U.S., but owned by non-U.S. companies, account for nearly 40 percent of U.S. anti-friction bearing capacity. However, no bearing company has a monopoly on bearing technology and quality.

Helicopter, missile, and tracked combat vehicle system integrators have no major concerns with their bearing suppliers. Lead times have remained relatively stable over the past three years. The cost of superprecision bearings in the helicopter business has increased moderately due to raw materials cost increases, product liability concerns, and costs to qualify alternate sources. System integrators obtain approximately 80-95 percent of their bearings from single sources, but all have processes in place to constantly monitor and maintain their suppliers. No work stoppages or delivery delays are anticipated for Army programs.

Domestic bearing manufacturers are specialized but are able to meet the Army's bearing requirements for tracked combat vehicles, missiles, and helicopters today, and will continue to be able to support Army requirements in the future. Due to the long lead times for superprecision bearings, both producers and the Army would benefit if the Army provided projected future requirements to its producers in a more timely manner. The bearing industry, however, is adequate to meet the Army's requirements.

4.4 Navy

Fiscal Year 2001 Shipbuilding Plan (February 2000)

The Navy prepared this overview to provide information for congressional staff personnel during budget hearings. It focused on Newport News Shipbuilding and Dry Dock Company, General Dynamics' Electric Boat Division, National Steel and Shipbuilding Company, Bath Iron Works, Ingalls Shipbuilding, and Avondale Industries. This overview examined current and projected new construction, conversion, refueling, overhaul, and repair workloads at the shipyards for the period 2000 - 2012. For each shipyard, the Navy summarized information associated with military and commercial ship programs, and employment. Additionally, the overview summarized funding and construction progress information for each Navy ship construction program.

CVNX Industrial Assessment (April 2000)

This assessment was prepared to determine if industrial and technological capabilities will be sufficient to support the Navy's Future Aircraft Carrier (CVNX) Shipbuilding Program. The Navy concluded that despite consolidation in the defense industry there likely will be sufficient industrial and technological capabilities available to support the CVNX shipbuilding program; the overall level of risk is low. Long lead-time components should be available within the timeframes required. Additionally, the Navy concluded that Newport News Shipbuilding and Drydock Company will maintain a work force of about 18,000 employees through 2006, when the contract for CVNX-1 is to be awarded. This work force level will sustain adequate workers and skills for the CVNX-1 and also enable workload-leveling efficiencies.

SH-60R Seahawk Helicopter Industrial Assessment (June 2000)

This assessment was designed to identify mechanisms to reduce SH-60R total ownership costs. It focused on the T-700 engine manufactured by General Electric. This engine has experienced less than desired service life for Blisk blade turbine assemblies. The assessment concluded that commercially available turbine blade coatings had the potential to increase engine performance and reliability, thereby reducing total ownership costs. General Electric uses these coatings for several of its commercial engines.

General Electric and the Navy are considering a Value Engineering Change Proposal to incorporate this commercial coating into T-700 turbine blades for all future DoD H-60 aircraft.

F-14 Tomcat Industrial Assessment (October 2000)

This assessment was designed to examine the feasibility of employing commercial solutions to address ongoing problems associated with corrosion deterioration of the F-14's aluminum honeycomb skin. The Navy concluded that anti-corrosion coatings used by commercial airlines could improve F-14 aluminum honeycomb skin corrosion protection. Preliminary testing results indicate the commercial coating will reduce corrosion for virtually all naval aircraft.

Arleigh Burke (DDG-51) Class Industrial Base Study (October 2000)

Section 122 of the National Defense Authorization Act for FY2001 directs the Secretary of the Navy to provide to Congress a report that updates information included in the *Arleigh Burke (DDG-51) Class Industrial Base Study of 1993*. The Navy completed this report and provided it to Congress in October 2000. The assessment divided the industrial base supporting DDG-51 Class ships into five categories: (1) hull, mechanical, and electrical suppliers; (2) ship systems design and engineering; (3) combat systems suppliers; (4) combat systems engineers; and (5) shipyards. Based on projected procurement rates, the shipyards (Bath Iron Works and Ingalls Shipbuilding) may be challenged to maintain earnings, overhead rates, ability to make capital investments, and skilled workforces.

4.5 Air Force

Application of Advanced Software Tools for Design and Production in the Aerospace Industry (January 2000)

The complexity of designing, testing, and producing defense aerospace systems necessitates the use of state-of-the-art engineering and manufacturing information systems. The use of these automated tools, in turn, has resulted in acquisition cost and cycle time reductions. To baseline current industry practices and forecast requirements for future modeling and simulation tools, the Air Force Research Laboratory conducted a survey of over 250 aerospace manufacturers and software vendors. The Air Force collected information on specific software tools in use today, limitations associated with those tools, requirements for future tools, and barriers to the introduction of new software tools.

Survey responses indicated that software tool evaluations should be centered on cost-effectiveness, ease of use, communication between applications, and performance limitations (of both software and hardware). The study concluded that next generation engineering design and manufacturing engineering tools should incorporate several key features:

- More automated features to reduce overall manpower requirements (training, programming, coordination, communication).
- Better interaction between tools/seamless connection/web-based architecture.
- Integration of cost modeling into design and manufacturing simulations.
- 3-D simulation and affordable virtual reality.

As a result of the survey, the Air Force structured a \$20 million Manufacturing Technology Program -- the Initiative for Modeling & Simulation Affordability (IMSA). IMSA will develop, demonstrate, and implement advanced, affordable, and robust product/process modeling and simulation technologies. It will provide system engineers, designers,

manufacturing engineers, and government and industry decision-makers with greater visibility into system producibility and affordability.

Defense Satellites Suppliers Mapping (April 2000)

Consolidation across the defense industry has raised some concerns that competition and innovation in the supplier base are at risk due to the "vertical integration" of Original Equipment Manufacturers (OEMs). Such concerns have been expressed frequently in the Space sector where the capability to design and build both launch vehicles and payloads now resides in several large firms. This study examined twelve critical components and technologies and identified approximately 40 key suppliers for current unclassified satellite programs.

The study found that the satellite industrial base generally is robust. Although mergers and acquisitions have reduced the number of Space sector OEMs:

- In each of the twelve areas assessed, there were at least two and often six or more companies with expertise in developing and manufacturing satellite products.
- Over 10 percent of the firms identified were niche manufacturers marketing innovative technology solutions, not traditional military contractors.
- Electronics segments (sensors, data processing, receivers/transmitters) were the most competitive within the sector.
- The propulsion and structures segments had fewer competitors.

The study concluded that decreases in defense spending and consolidation across the defense industrial base had reduced the overall number of suppliers in the satellite sector; but had not yet adversely impacted competition or entry by new firms into the market.

The Air Force Space and Missile Systems Center will emphasize military-unique items with diminished sources (e.g., radiation hardened electronics) and affordability issues in future studies and investments.

Aircraft Radome Industrial Base Analysis (April 2000)

Aircraft radomes are designed to minimize degradation of signal transmission and receipt of such transmission from aircraft subsystems (for example radar, communications, and electronic countermeasures subsystems). As the radome ages and repairs are made, the radio frequency (RF) performance characteristics of subsystems may change or degrade. The Airborne Warning and Control System (AWACS) OEM (Boeing Aerospace) recently deactivated its AWACS radome far field test facility. There currently is no other capability to test the RF performance characteristics of the AWACS radome when installed on the aircraft. The Air Force Electronics System Center performed this assessment to identify technologies that could be used to test large radomes without removing them from the aircraft. The Air Force

evaluated commercial and government test methodologies, and technologies now in use and emerging from the laboratory.

The assessment concluded that the Mobile Diagnostic Laboratory (MDL) developed by the Air Force Research Laboratory's Avionics Laboratory could be utilized to evaluate AWACS radome RF performance characteristics. The MDL represents a relatively simple and cost-effective capability to detect functional degradation associated with the radome before performance reductions impact mission availability.

As a result of the study, the Air Force is planning to: (1) set up a technology applications demonstration; (2) develop a preliminary design on a deployable capability; and (3) explore the feasibility of applying the concept to other large aircraft radome platforms.

Report on the Status of the Aircraft Industry (June 2000)

A team sponsored jointly by Air Force Research Laboratory and the Industrial College of the Armed Forces (ICAF), comprised of students and faculty from ICAF, assessed the health of the U.S. aircraft industry. The study addressed military and commercial product lines for both fixed-wing and rotary-wing aircraft. The team visited ten U.S. manufacturers and also considered information from site visits to seven European aircraft manufacturers.

The assessment concluded that:

- After a decade of mergers and downsizing, the industry's four main sectors -- commercial fixed-wing aircraft, military fixed-wing aircraft, rotary-wing aircraft, and jet engines -- are competing with European firms from a weakened position. To sustain profitability and maintain market shares, aerospace manufacturing companies are striving to streamline production processes, reduce overhead costs, and enter into strategic partnerships to stimulate revenue-generating opportunities.
- Industry-wide, profit margins remain flat compared to the profitability and return on investment levels enjoyed by traditional blue-chip companies and "new economy" information technology firms. DoD procurement policies tend to restrict profitability through caps on fees and profits. To compensate, the aircraft industry is pursuing strategies to increase after-market business and optimize supply chain relationships (vertical integration versus outsourcing).
- Aerospace R&D funding has fallen by over 50 percent from a 25-year peak in 1987. Expectations that private R&D funding would increase to offset federal investment cuts have not been realized. The defense industry has shortened the timeframe within which it expects to receive an adequate return on an R&D investment to less than 10 years; as much as 80-90 percent of R&D resources now are committed to short term development and process improvement.
- Several options offer promise to overcome difficulties associated with the recruitment and retention of a capable aerospace workforce. These include expanded teaming with

schools and nearby high-technology employers, more new research and design project starts, and increased productivity (both engineering and production) through the use of modern processes and advanced simulation and modeling techniques.

The Air Force is distributing the report and considering how best to use the information contained therein.

Joint Direct Attack Munition Surge Industrial Base Analysis (August 2000)

The Joint Direct Attack Munition (JDAM) is a tail and guidance kit primarily for the 2000 lb. BLU-109 (Hard Target Penetrator) and Mk 84 (Blast-Fragmentation) bombs carried by a host of allied platforms. JDAM inventories were depleted severely during recent military operations in Eastern Europe. The Air Force conducted this assessment to evaluate the ability of suppliers to surge JDAM production; and also to determine if a recently developed Surge Simulation Software engine provided the type of analysis, level of examination, and depth of results required.

The Air Force performed a comprehensive assessment of the production capabilities of the JDAM industrial infrastructure, including supplier subsystem and component manufacturing characteristics (for example, production rates, long lead times, surge capabilities, etc.). The Air Force focused particular attention on the JDAM's Inertial Measurement Unit (IMU) subsystem. The Air Force used the Surge Simulation Software engine to assess the interrelationships among the suppliers of components, the customers of these components, and the end products they support; and to evaluate multiple levels of demand for each production facility. In Phase I, the Air Force considered surge production of JDAM units, only. In Phase II, the Air Force considered the need to surge production of several different weapon systems, each using the same or very similar IMUs.

The Phase I analysis identified suppliers of several structural components and batteries as choke points. No JDAM configurations could be surged within six months. In most cases, this delay was due to the need to add a second shift to increase production. During Phase II, higher IMU demand for four other weapon systems led to a production output choke point at the IMU supplier and caused deliveries to be delayed for several programs.

The Air Force concluded that advance planning resulted in the identification of actions that can reduce lead times and improve the likelihood of timely production. The Air Force also concluded that Surge Simulation Software is an excellent tool for providing visibility into the capabilities of weapons producers. The Air Force is considering using Surge Simulation Software both for inventory management to support the warfighter and for acquisition planning (for example, second source availability of crucial components).

Wiring Integrity Analysis on Legacy Aircraft (September 2000)

As used in this summary, the term "wiring" includes the wires themselves, connectors, relays, circuit breakers, power distribution components, and generators. Military aircraft wiring integrity has become a readiness issue due in part to increased awareness attributed to recent

commercial aircraft wiring mishaps. The Air Force typically does not report wiring as the cause of maintenance actions; therefore, the magnitude and pervasiveness of wire integrity issues are not well documented. Air Force and contractor personnel conducted this multi-site review to document test methods, techniques, and the types of wiring faults found by Air Force depot, operational, and maintenance personnel. The analysis also included a survey and review of the current capabilities of commercial wire testers and identified basic requirements for a field-level wiring tester. Specifically, the analysis was designed to ascertain the feasibility of using wire integrity test equipment to evaluate aircraft wiring and enhance existing maintenance operations.

The field survey team visited Ogden, Oklahoma City, and Warner Robins Air Logistics Centers; Luke Air Force Base; and the Springfield, OH, Air National Guard. Using information gathered via questionnaires and interviews with engineering and maintenance personnel, the team examined wiring for F-15, F-16, C-5, C130, C141, KC-135, B1-B, and AWACS aircraft. The team found that wiring is a significant contributor to sustainment costs; and that current visual inspection methods and handheld tools are inadequate to identify most wiring problems. Faults such as chafed wire insulation and broken wires occur most frequently in high stress or harsh environment areas, such as fuel tanks, anti-skid systems in wheel wells, generators, wing flaps, leading edges, and control columns.

The team presented its findings and conclusions to Air Force field level maintainers; and representatives from the Air Force operational Commands, System Program Offices, the U.S. Navy, the Federal Aviation Administration, and National Aeronautics and Space Administration. As part of an active wire integrity program within its "Aging Aircraft Initiative," the Air Force will begin to collect and analyze wiring integrity information, systematically. Additionally, the Air Force is planning initiatives to develop both new tools to manage aging wiring and a new wiring tester.

4.6 Defense Logistics Agency (DLA)

Chemical Protective Gloves Follow-on (April 2000)

Chemical protective gloves are an integral part of the chemical protective ensemble used to protect troops from chemical and biological weapons attack. This assessment reevaluated issues previously addressed in Fiscal Years 1996 - 1999. It was designed to determine if essential industrial capabilities would be lost in the absence of peacetime DoD procurements. DLA concluded:

- These gloves are military-unique. Butyl rubber is the only known material capable of meeting all Service requirements for protection against chemical and biological agents. The butyl rubber solvent dipping process used to produce the gloves requires unique manufacturing processes and hazardous material recovery equipment. The specialized equipment needed and requirements for special licenses from the Occupational Safety and Health Administration and the Environmental Protection Agency discourage entry of new sources.

- The gloves have a shelf life of 15 years; extended from 5 years as the result of a shelf-life extension program. Even with these extensions, the Department expects significant Service inventory attrition during the next 2-3 years.
- Two companies, North Safety Products and Guardian Manufacturing, have the equipment and licenses required to manufacture butyl chemical protective gloves. Under the terms of an Industrial Base Maintenance Contract (IBMC), each is required to ensure it has sufficient production capacity to meet planned replenishment requirements. (Absent the IBMCs, peacetime production would provide insufficient incentive for the contractors to retain protective glove industrial capabilities. The IBMCs ensure the industrial capabilities are preserved; however, they do not sustain sufficient surge production capacity to overcome inventory shortfalls.)
- The Department had anticipated that the Joint Services Lightweight Integrated Suit Technology (JSLIST) Program would introduce a new generation glove in 1997. Under the pre-planned product improvement program, the first sample was delivered for testing in October 1997. Indications were that these gloves could be produced on the same production lines being sustained under the IBMC. However, the samples did not pass chemical agent testing. New tests are not expected until 2003. Continuing the IBMCs ensures that DoD retains the ability to meet projected glove requirements until a new glove is proven satisfactory.

In April 2000, DLA awarded the last of a series of 1-year IBMC contract options, totaling \$4 million, to both North Safety Products and Guardian Manufacturing to sustain industrial capability.

Sutures, Bandages and Medical Materiel (July 2000)

DoD uses sutures, bandages, and surgical instruments to close and protect cuts, incisions, and lacerations stemming from surgery or trauma. DoD's wartime requirements for these items (and other medical materiel such as gloves, wraps, and gowns) present significant challenges. It is difficult to determine what types of sutures, bandages, and other medical materiel actually are being produced, stored, and sold to meet commercial demand. This lack of commercial manufacturer product line and production capability information hinders DoD's ability to prepare for projected operational scenarios.

In 1998, DLA assessed sutures to determine if there were sufficient industrial capabilities to meet wartime demand. On August 27, 1998, DLA awarded Johnson and Johnson's Ethicon Division a \$2 million Corporate Exigency Contract (CEC) establishing a long-term partnership to: (1) obtain manufacturing data regarding products currently in production; and (2) provide an ability to meet projected increases in demand for wartime medical supply sustainment. In 1999, DLA reassessed suture requirements and also evaluated the industrial capabilities required to meet projected bandage requirements. In 2000, DLA reevaluated sutures and bandages; and assessed other medical materiel industrial capabilities required to meet projected requirements. The assessment concluded:

- There are several manufacturers of bandages, sutures, and orthopedic supplies. Items are supplied in various sizes, types, and styles, which make standardization difficult.
- Medical and surgical supply manufacturers cannot support the DoD's projected time-phased contingency sustainment requirements.
- Bandages, sutures, and medical materiel are an ever-changing commodity; a style or size used today may become obsolete over the next 6 months.
- The CEC concept is an innovative and valuable industrial preparedness measure that combines aspects of Vendor Managed Inventory (VMI), stock rotation, and commercial asset visibility.

In 2000, DLA awarded CEC contracts totaling \$8.4 million to increase its ability to acquire sutures, bandages and medical materiel supplies. DLA now has access to over 1175 medical/surgical items at seven manufacturers, providing extensive readiness/contingency coverage for these product lines. DLA's goal is to acquire, by the end of 2004, the ability to meet all of its medical/surgical commodity readiness/contingency requirements.

Nerve Agent Antidote Autoinjectors Follow-on (July 2000)

Nerve Agent Antidote (NAA) in Autoinjectors is a military-unique item designed for rapid self-administration through clothing upon exposure to a nerve agent. DoD uses two styles of autoinjectors -- Atropen and Combopen. Both are front-end activation injection devices. Atropen-style autoinjectors use a stainless steel cartridge to inject atropine. Combopen-style autoinjectors use a tempered glass cartridge to inject Pralidoxine Chloride or Diazepam. The Army uses Atropine and Pralidoxine Chloride autoinjectors packaged together in "Mark I" kits. The U.S. Food and Drug Administration (FDA) must approve the antidotes, autoinjectors, and manufacturing processes. During FY2000, DLA contracted with KPMG, an independent contractor, to assess industry's ability to meet DoD requirements. The assessment concluded:

- To comply with Title 10 U.S.C. section 2534, DoD restricts the purchase of chemical weapons antidotes contained in automatic injectors or components for such injectors, to those manufactured in the U.S. and Canada.
- Although peacetime requirements are low, NAA in Autoinjectors must be available quickly, in large quantities, in the event of a military contingency. Peacetime requirements are insufficient to sustain a source of supply.
- Quantities required to meet mobilization requirements greatly exceed peacetime needs. Projected NAA mobilization requirements, as identified in the 2000 Joint Chemical Rates Study, increased from previous projections.
- Meridian Medical Technologies, Inc. (MMT) is the only FDA-approved manufacturer of NAA in Autoinjectors suitable for the U.S. Military Services.

- There are no viable alternative sources of supply. Significant barriers to entry (including small demand in peacetime, significant investment in plants and equipment, and a time-consuming FDA approval and re-certification process) discourage potential new suppliers.
- DLA's Readiness Enhancement Program (REP) initiative supports additional long-lead item component prepositioning and purchases of additional equipment needed to increase production capacity. This initiative provides additional wartime capability not covered under an existing IBMC.
- Due to increased Service requirements, the IBMC, coupled with an REP, is the most efficient mechanism to preserve this critical manufacturing source.

DLA has had an IBMC with MMT since 1992. The contract ensures that a valid capability to manufacture NAA in Autoinjectors will be maintained despite unstable peacetime demand. The IBMC requires that MMT maintain a capable workforce and facilities, provides for component prepositioning, and requires the storage at MMT of NAA in Autoinjectors for which shelf lives have expired -- but which remain potent -- in a service life extension program. In July 2000, DLA invoked the first of two one-year contract options to the base IBMC contract awarded in 1999. In September 2000, DLA spent \$1.062 million to modify the IBMC to include three additional contract line items that collectively constitute the REP. The IBMC and REP ensure that industrial capability and capacity are adequate to meet the Services' NAA in Autoinjectors surge and sustainment requirements.

Gelatin Sponges Follow-on (July 2000)

Gelatin sponges are absorbable sponges that are impregnated with Gelfoam®, a gelatinous material. When the sponge is applied to an open wound, the gelatin paste interacts with the oozing blood to form a protective barrier that hastens the clotting process. DoD plans to use the sponges for the majority of expected wartime casualties. Projected wartime demand significantly exceeds peacetime demand. This reassessment was designed to determine how to ensure that DoD would have access to gelatin sponges in sufficient quantities to meet projected wartime requirements. The assessment concluded:

- The technology involved in the production of gelatin sponges precludes rapid production increases.
- The gap between the ability of the current manufacturers and distributors to supply gelatin sponges and the Services' requirements is projected to increase precipitously after day 45 of a conflict.
- The Services have increased their wartime requirements for gelatin sponges.
- New manufacturers are expected to enter the market in the future.

- The current VMI arrangement has dramatically improved the availability of sponges to meet wartime requirements.

DLA added gelatin sponges, at a cost of \$214,000, to a VMI contract for pharmaceuticals originally awarded in 1997. In 2000, DLA increased the VMI contract by \$150,000 to cover increased projected Service wartime requirements for gelatin sponges.

Patient Care Items Follow-on (July 2000)

In 1999 and 2000, DLA performed a capabilities assessment on several patient care items. In 1999, manufacturers of four of the items were incapable of meeting the Services' wartime needs. Urethral Catheterization Kits are used during surgical procedures to analyze bladder contents. Blood Collecting-Dispensing Bags and Donor Sets are used to collect blood from, or dispense blood to, appropriate personnel. Sterilization Indicator Liquids are utilized to evaluate sterilizers for effectiveness. Blood Testing Kits are used to perform blood and platelet counts on patients. In 2000, DLA conducted another assessment and found that manufacturers for an additional eleven patient care items could not meet Service requirements. These items (including the four items assessed in 1999), all have shelf lives ranging from 15 - 24 months, are used to save or sustain life or limb or reduce impairment or disease, and have projected requirements that increase significantly immediately after a conflict begins. The assessment concluded:

- The capability of the industrial base to support the Services' requirements rapidly declines after the first 20 days of a conflict and does not significantly improve until 150 days after a conflict begins.
- Even with production committed to these items, the industrial base cannot provide sufficient quantities to meet the Services' requirements.
- Due to shelf-life considerations, manufacturers and distributors do not keep significant levels of materiel on hand.

In July 1999, DLA awarded a \$1.4 million VMI surgical contract for patient care items. Materiel is stored at the vendor's facility and rotated to commercial customers. In this way, fresh materiel is always available to the Services. The VMI contract provides DoD a vehicle by which the Services and DLA have a mechanism to update requirements and resolve surge and sustainment issues. During 2000, DLA modified the VMI contract by adding \$64,000 for maintenance and storage fees to rotate the existing stock and provide additional capability for the eleven new items. If needed, the materiel will be available immediately. This modification satisfies the demands of early deploying units and provides time for the industrial base to increase production to meet follow-on demand.

Pharmaceuticals (July 2000)

Pharmaceutical drugs recently added to VMI contracts are classified into three major categories of antibiotics -- Amoxicillin to fight battlefield infections, ciprofloxacin for the anthrax

treatment protocol, and analgesics for pain relief. These drugs lose potency and strength after a scientifically predetermined timeframe; shelf life on these items can range from six months to more than two years. In 2000, DLA performed an assessment to determine if the pharmaceutical industry could meet DoD's surge and sustainment requirements. The assessment concluded:

- The Services have large requirements for many medical items, especially in the early phases (0-60 days) of a conflict. The normal production lead-time for most medical stock items is 120 days.
- Thirty pharmaceutical items not previously identified in other industry assessments have Service wartime requirements that DLA cannot procure in the time frame or quantity desired.

In September 2000, DLA modified its existing VMI pharmaceutical contract with Bindley Western Drug (BWD) to include an additional 30 items, at a cost of \$350,000. Additionally, DLA added \$50,000 for rotation and maintenance fees for items already under the BWD VMI contract. Modifying this contract provides DLA with inventory management and guaranteed access to inventory that is rotated with the contractor's commercial sales. In the event of a conflict, DLA would draw on that inventory until the industrial base could increase production to meet DoD requirements.

Gas Spin Bearing (August 2000)

The gas spin bearing (GSB) is used on the LGM-30G Minuteman Intercontinental Ballistic Missile (ICBM III), a key element of the nation's strategic deterrent forces. The sole function of the GSB is to orient the guidance system to true north. Without the GSB the missile system would not function. The ICBM III currently is being overhauled. Boeing Corporation is the prime contractor. DLA manages the GSB for DoD; no new GSBs have been required for the past five years. DLA conducted this assessment to determine if current production capability is available to produce GSBs in sufficient quantities and timeframes to meet planned sustainment requirements. The assessment concluded:

- Depot overhauling of the ICBM III will continue through 2025 at a rate of 100 per year. To support this depot repair operation, DoD will require an initial quantity of 120 GSBs in 2002, and 60 bearings annually, thereafter.
- The GSB is unique. There are no substitutes, higher assemblies, or other systems that can be used to replace it. The GSB is employed only in wartime, but must remain operational in the guidance system of the ICBM III during peacetime.
- The manufacturing procedure is complex and requires several processes and inspections. The machining process requires unique milling and lapping processes that are not readily available from precision machine shops. The final machining process, a lapping operation where the last ten microns are removed at half-micron increments to keep from crystallizing the metal, is completed by hand.

- The GSB has been out of production for an extended period of time. The only qualified machine/lapping sources have lost their technical experience and tooling and, therefore, are no longer able to produce the item.
- Condor Pacific Industries, Heath Division, is the only company with a complete data package for manufacturing the GSB.

DLA is taking steps to reactivate the industrial base but is not purchasing end items. On August 18, 2000, DLA awarded a \$1.2 million contract to Condor Pacific Industries to reestablish the capabilities required to produce GSBs. In Phase 1 of the contract (the only phase now funded) Condor Pacific will pre-qualify candidates for subcontracts. Phase II, not part of the initial funding, will be delivery of new GSBs, accomplished via projected peacetime buys. Reestablishment of the capability to produce the GSB, will ensure that DoD has adequate capability available to support readiness of a primary component of strategic nuclear defense.

Chemical Protective Suit Liner Fabric Follow-on (September 2000)

The Battle Dress Overgarment (BDO) chemical-protective ensemble is out of production and is being replaced by the JSLIST ensemble. DoD is replacing BDO war reserve inventories with JSLIST ensembles as BDO shelf life expires. In 2000, DoD awarded contracts for approximately 500,000 JSLIST suits. Five manufacturing facilities, four of which are controlled by the National Industries for the Severely Handicapped (NISH), produce JSLIST suits (as required by the Javits, Wagner, O'Day Act). Von Blucher GmbH, a German firm, owns the patent for the JSLIST suit liner fabric. Von Blucher opened a partial manufacturing facility in Maine last year. Our North Atlantic Treaty Organization allies use the same suit liner technology for their chemical protective suits. DLA conducted an assessment to determine if current production capabilities are adequate to meet planned surge requirements. The assessment concluded:

- Inventory shortfalls preclude DoD's ability to meet Service wartime requirements. The Services continue to purchase JSLIST suits at a rate that uses nearly all of the industry's peacetime capacity, but because many of the suits purchased are used to replace existing BDOs being removed from the inventory, these peacetime purchases have a relatively small impact on the wartime requirement shortfall.
- The suit manufacturing base can be effective in increasing capacity to attack this shortfall during wartime conditions only if there is a source of raw material in place to surge manufacturing while fabric suppliers increase production.
- While Von Blucher has sufficient production capacity to meet planned post-conflict replenishment requirements, it would take four months to acquire the raw material needed to produce fabric liner in excess of peacetime requirements.
- Absent a "readiness bubble" of fabric liner stored within the continental U.S., DoD would be unable to immediately surge and sustain production above peacetime levels.

- DLA has awarded a series of liner fabric contracts to Von Blucher GmbH through its wholly owned U.S. selling agent, Tex Shield. DLA now has a liner fabric reserve of 185,000 yards; enough to produce approximately 56,000 JSLIST suits. The contracts also provide for fabric storage, currently in Maine, in close proximity to two of the five suit manufacturing facilities. DLA is developing a mechanism to rotate the liner fabric reserves into JSLIST production pipelines, ensuring reserve fabric is used before shelf life expires.
- The liner fabric reserve is sufficient to accommodate the surge capacity of the suit manufacturers for the first 45 days of a conflict.
- To expedite the manufacturer's lead-time to produce fabric liner, prepositioning of long lead-time raw materials, carbon beads, is necessary.
- Prepositioning carbon beads at the fabric liner manufacturer's facility is more cost-effective than storing and rotating the fabric liner. In addition, shelf life is less of a concern with the carbon beads.
- The fabric liner manufacturer currently purchases carbon beads from a company located in Japan. The lead-time to acquire the carbon beads is four months.

During 2000, Von Blucher installed a fabric liner coating and lamination machine in the Maine facility. DLA decided to purchase an initial quantity of carbon beads in 2000 so that they would be available when the facility becomes operational. The prepositioned carbon beads at the Maine facility and the prepositioned fabric allow DLA to accommodate the suit manufacturers' surge capacity for the first 60 days (an approximate total of 89,000 suits). In 2000, DLA awarded a \$3.1 million contract to Von Blucher for initial purchase and storage of carbon beads and continued storage and rotation of the liner fabric. In 2001, DLA will continue to evaluate and develop cost-effective approaches to further mitigate the surge requirement shortfalls.

Unitized Group Ration Assembly Equipment Readiness Investment (September 2000)

The Unitized Group Ration (UGR) is an integral part of the operational rations feeding system used to sustain military personnel during worldwide operations. The UGR is designed to maximize the use of commercial items and to simplify the process of providing high quality food service in a field environment. Typically, a UGR includes all components for a complete 50-person meal. DLA purchases the components and has them shipped to two DLA depots for assembly into complete meal modules. DLA began an assessment of depot assembly capacity in 1999 and completed it in 2000. This assessment concluded:

- The demand for group feeding rations during mobilization exceeds the depot's assembly capacity. Even at maximum production capacity, the depots will not be able to meet 33 percent of UGR wartime requirements.
- Increased assembly capacity is dependent on equipment, warehouse space, and labor availability.

The DLA assembly depots committed to allocate additional warehouse space and labor resources to enhance production capabilities. In 2000, DLA also awarded contracts totaling \$345,000 to purchase equipment to expand depot assembly capability. The equipment will be secured in a container for storage and will be available immediately to supplement existing assembly capacity, both within the United States and overseas. This will reduce the lead-time to provide the finished modules to the Services.

4.7 Ballistic Missile Defense Organization (BMDO)

Theater High Altitude Area Defense Industrial Capabilities Assessment (July 2000)

BMDO Project Offices perform and update industrial capabilities assessments on an on-going basis to support major program milestone decisions. This assessment was conducted for the Theater High Altitude Area Defense (THAAD) program. The assessment, required as part of the THAAD program's acquisition strategy, evaluated production risk as the program entered Engineering and Manufacturing Development. The assessment concluded that there is low-to-medium risk that the industrial base required to develop, produce, and support the THAAD weapon system will not be ready when needed. The program's high reliance on "commercial-off-the-shelf" and "military-off-the-shelf" products contributed to this finding. While several industrial capabilities issues were identified, the THAAD Project Office is implementing and/or reviewing appropriate risk reduction methods. The Project Office will continue to monitor industrial capabilities issues and be proactive to assure that a strong domestic industrial base is available to support requirements throughout the program lifecycle.

5. Related Activities

5.1 Industrial Capabilities Improvement Activities

In addition to performing industrial capabilities analyses, several DoD programs and/or activities specifically seek to develop or improve industrial capabilities.

DoD Manufacturing Technology Program

DoD's Manufacturing Technology (ManTech) Program develops new and improved manufacturing processes to facilitate more affordable production of DoD weapon systems and components. The Program addresses process technology issues from the systems development phase through transition to production and into sustainment. ManTech investments target defense-essential needs that industry would not otherwise pursue in a timely manner. ManTech improvements generally translate into cost avoidance or cycle time reductions. However, investments also focus on developing "new" capabilities that actually may result in a more expensive component, but will provide dividends in system performance or life cycle cost that far outweigh the initial cost. The DoD ManTech Program is structured around two major thrust areas:

- *Processing and Fabrication* activities develop affordable processes for metals, composites, and electronics by improving factory floor and repair and maintenance facility (depots, logistics centers, and shipyards) processes.
- *Advanced Manufacturing Enterprise* activities accelerate implementation of world-class industrial practices, advanced design, and information systems that support weapon system development, production and sustainment.

In addition to the two thrust areas, the ManTech Program also includes two special emphasis areas:

- *Energetics/Munitions* projects focus on improving processes associated with propellants, explosives, pyrotechnics, reactive chemicals, and conventional munitions.
- *Sustainment* projects coordinate common DoD opportunities to increase the reliability and reduce the cost of repair processes for aging systems.

In response to the requirements of 10 U.S.C. section 2525(e), the Department issues an annual Five-year Plan for the ManTech Program¹⁰ in February of each fiscal year. The March 2001 Plan will:

- Describe the ManTech Program's goals, priorities, and investment strategy.

¹⁰ The current Plan is available on the Internet (<http://mantech.iitri.org>).

- Present Military Department and Defense Logistics Agency funding for FY2001, and planned funding for FY2002 through FY2006.
- Include a description of all projects completed in 1999 and 2000, and the status of implementation.
- Assess the extent of cost sharing with commercial enterprises, defense program offices, other federal agencies, institutions of higher learning, and other sources.
- Summarize program measures of effectiveness and the results of internal and independent reviews.
- Provide examples of success stories and achievements.

Title III of the Defense Production Act

The Defense Production Act (DPA) (50 U.S.C. App. 2061 *et seq.*) is the primary legislation designed to ensure that the industrial resources and critical technology items essential for national defense are available when needed. Title III of the DPA provides a vehicle to establish, modernize, or expand domestic production capability and capacity for technology items, components, and industrial resources that are essential for national defense. It does this provided that no domestic capacity exists, or that the domestic capacity that does exist is insufficient to meet defense needs. Under the authorities of Title III, DoD can provide domestic firms with a variety of financial incentives to reduce the risks associated with establishing the needed capacity. These incentives include purchases or purchase commitments, loans and loan guarantees, development of substitutes, and the purchase or lease of advanced manufacturing equipment which can be installed in government or privately owned facilities. DoD uses purchases and purchase commitments most frequently. A key objective of the Title III Program is to accelerate the transition of new leading edge technologies from research and development to affordable production and to insert those technologies into defense systems.

The Department organizes and executes the Title III program as a DoD-wide program, generally focusing on materials and components that can be used in a broad spectrum of defense systems. The Office of the Secretary of Defense provides top-level management, direction, and oversight. The Air Force, acting as the Executive Agent for this program, structures and executes approved and funded projects for the Department. In 2000, the Department initiated three Title III projects, began development of two others, and completed one project.

Silicon-on-Insulator (SOI) Wafers

SOI substrates can significantly reduce costs and improve the performance of low power and/or radiation-tolerant integrated circuits used in military satellite communications systems, ballistic missile upgrades, surveillance systems, and inertial navigation systems. This project will establish domestic sources for SOI wafers (up to eight inches in diameter) that have emerged from research and development but which require lower-cost, higher-volume production capabilities before they can be inserted affordably into DoD systems. The project is designed to

provide sufficient incentives to create a domestic SOI wafer production capacity of 1.4 million square inches per year. This project was initiated in March 2000 and will be completed in approximately 48 months. The total value of this effort, including industry cost sharing, is \$14.3 million.

Laser Protective Eyewear

This project will establish a highly responsive, affordable production capacity for thin film dielectric coatings on polycarbonate substrates. These substrates are the basic component in laser protective eyewear such as helmet visors, goggles, and spectacles. The widespread proliferation of lasers in military operations is posing an increasingly significant threat of eye injury to military personnel. The project will assure that domestic producers are available to supply these devices in sufficient quantities and at affordable prices to meet defense needs. This Title III project is using purchase and purchase commitment incentives to assist in establishing a viable, domestic production capacity on a high-volume, commercial ("dual-produce") line for laser protective eyewear for military and commercial applications. This project will also accelerate the implementation of compatible interference filter technologies, such as dry process holographic filters and/or rugate filters, to protect against a broader range of laser threats. The Services strongly support this project since it enables the timely production and fielding of affordable protective eyewear that meets their requirements for protection and operational effectiveness. The total value of this project, including industry cost sharing, is \$6.2 million. The project was initiated in August 2000 and is expected to be completed in approximately 36 months.

Microwave Power Tubes

Microwave power tubes generate and amplify microwave energy in radar systems, electronic warfare systems, and telecommunications systems and are required for applications requiring high frequency and high power. Microwave power tubes are a critical element underpinning current and future operational capabilities of most major defense systems and will be needed for the foreseeable future since there are no replacement technologies on the horizon. There are approximately 1,000 different types of microwave tubes used in 270 military systems (over 180,000 total tubes). This project will facilitate the Department's assured access to affordable microwave power tubes by providing incentives to encourage lower tier microwave power tube suppliers to make consistent, quality-driven improvements. DoD's goal is to transition advanced manufacturing processes to the lowest-tier suppliers; thus improving overall quality and lead times and driving down the production and life cycle costs of microwave power tubes to the DoD. The Department will use Title III authorities to facilitate supplier process improvements, qualify alternate materials and processes, and share integration and investments both horizontally across the supplier base and vertically between suppliers and tube manufacturers. Congress appropriated \$3.0 million in the FY2000 Defense Appropriation Act (P.L. 106-79) and an additional \$2.0 million in the FY2001 Defense Appropriation Act (P.L. 106-259) specifically for this Title III project.

Radiation Hardened, Thin Film SOI Wafers for Digital Devices

DoD is developing this project to establish domestic production capacity for radiation hardened, thin film SOI wafers for a variety of digital circuit applications. Radiation hardened, thin film SOI wafers are used for fabricating radiation resistant ultra large scale digital devices such as microprocessors, application specific integrated circuits and static random access memory circuits. SOI technology materials are essential to defense telecommunications systems, ballistic missile systems, surveillance systems, radar, passive sensors, and inertial navigation systems. They provide a superior technology for sensitive battery powered applications due to reduced power requirements, increased device density, and faster device performance. This project will emphasize improving SOI wafer radiation hardness, quality, and yield; reducing wafer production costs; and promoting thin film wafer evaluation and qualification. Title III funding programmed for this project is approximately \$3.8 million.

Radiation Hardened Microprocessors for Missile and Space Applications

DoD is developing this project to establish a manufacturing capability for radiation tolerant and radiation hardened microprocessors for military and commercial space applications. The project will develop the manufacturing processes required to produce advanced commercial microprocessors that meet military requirements for radiation hardening. The project will create an accelerated (and repeatable) fabrication process, leveraging commercial capabilities for affordable production. DoD hopes to narrow the performance gap between state-of-the-art commercial microprocessors and radiation hardened microprocessors for military aerospace applications and to increase the capabilities of the domestic industrial base to supply advanced microprocessors for military missile and space applications. Title III funding programmed for this project is approximately \$7.5 million.

Semi-Insulating (SI) Indium Phosphide (InP) Substrates

InP substrates are vital to electronic defense applications requiring ultra high-speed operating frequencies (seekers and battlefield radar), lower power consumption (satellite crosslinks and battlefield communication systems), and exceptional low noise performance (Extra High Frequency low noise receivers and analog/digital converters). This project, completed in 2000, established a viable, long-term domestic manufacturing capability for InP wafers by accelerating the insertion of InP technology, expanding domestic production capacity, improving quality, increasing wafer diameter, and lowering production costs. InP substrates will have a far reaching, positive impact on DoD for several years to come. Savings for weapons systems alone have been calculated at \$35 million through the year 2004. The project also will have a major commercial market impact by increasing access to large diameter, high quality, affordable substrates supporting next-generation wireless consumer products and greatly enhanced Internet communication speeds. As a result of this project, wafer prices declined approximately 30 percent and the U.S. companies increased their global market share from less than one percent in 1996 to more than a combined 17 percent (forecasted) in 2000. Total funding for this project was \$10.1 million including cost sharing by the contractors.

DoD Technology Transfer Program

The Department created the Office of Technology Transition within the Office of the Secretary of Defense in response to 10 U.S.C. 2515, which called for DoD to establish a focal point to ensure that technology developed for national security purposes is made available to the private sector in the United States. The Office of Technology Transition has created a broad program to help the Nation achieve an improved return on its national security technology investment and, concurrently, improve the Nation's industrial competitiveness.

The Technology Transfer Program operates in a decentralized manner within DoD. The Military Departments are recognized as separate agencies for program implementation and have over 100 Offices of Research and Technology Applications (ORTAs) and other technology transfer focal points. These personnel communicate within DoD activities and with potential and existing partners in the private sector. The ORTAs and legal staff participate in both annual DoD Technology Transfer Integrated Planning Team workshops and the Federal Laboratory Consortium for Technology Transfer. The Department also has established a website to enhance communication with the private sector, advertise those federally developed technologies believed to have potential commercial application(s), and highlight success.¹¹

Some of the mechanisms being used in the DoD Technology Transfer Program include:

- Patenting and then licensing technology developed in DoD laboratories. This has proven to be an effective means to transfer technology both into Defense systems and commercial items.
- Cooperative Research and Development Agreements (CRADAs). DoD laboratories have entered into almost 2000 active CRADAs with the private sector. CRADAs allow DoD to provide personnel, services, and property to collaborating partners and to accept funds, personnel, services, and property from collaborating partners as the partners work together to develop new technologies.
- Partnership Intermediary Agreements (PIAs). DoD has six PIAs supporting efforts to transfer technology to the private sector. The most recent PIA, with Montana State University (MSU), was signed in July 1999. MSU is managing the TechLink Center in Bozeman, MT to help identify partners to develop technology, licensees for DoD technologies, and technologies of potential use to DoD. In its first year of operation, the TechLink Center helped complete 14 DoD-related partnerships in 6 of the 7 states in the Northwest United States.
- Using three legislative authorities (15 USC 3710a, 15 USC 3710(i), and 10 USC 2194), DoD has donated research equipment to educational and nonprofit institutions to assist in the development of scientists, mathematicians, and engineers to meet our future needs. In the state of New Mexico, DoD has entered into over 150 educational partnership agreements to donate equipment and/or provide faculty in these needed disciplines.

¹¹ (<http://www.dtic.mil/techtransit/>).

North American Technology and Industrial Base Organization

The Department co-chairs the North American Technology and Industrial Base Organization (NATIBO). NATIBO is chartered to promote a cost-effective, healthy technology and industrial base that is responsive to the national and economic security needs of the United States and Canada. Its primary purpose is to identify and analyze key technology and industrial sectors that are critical to defense, assess the viability of these sectors, identify issues and barriers related to sector viability, and develop strategies to enhance and sustain the health of the marketplace. NATIBO maintains a website¹² describing the organization, its accomplishments, and its ongoing activities. The website also contains copies of recent NATIBO industry assessments. A recent addition to the website, a "Research Development Test and Evaluation (RDT&E) and Production Capabilities" page, lists U.S. and Canadian RDT&E laboratories and centers and production centers. It also identifies facilities and equipment at those laboratories and centers that are available to the private sector.

In 2000, NATIBO published a *Study of the Rechargeable Battery and Battery Charger Technology and Industrial Base*. Rechargeable batteries are used increasingly in battlefield communications systems. The study analyzed rechargeable battery chemistries, battery charger systems, and technology trends; reviewed current and potential defense and commercial applications; and identified barriers to more widespread use. The study report provided recommendations for the U.S. and Canadian governments and industry to overcome identified barriers

The Defense Semiconductor Association

Ground Combat Systems (GCS) that have nuclear survivability requirements for initial nuclear radiation are military-unique and the semiconductor industry has little motive to provide semiconductors that will function in that environment. The Army formed the Defense Semiconductor Association (DSA) to coordinate unique GCS requirements with the capabilities of industry. The DSA is intended to be a vehicle to encourage semiconductor producers to build nuclear survivable GCS materiel.

The DSA is comprised of Army project offices, defense system prime contractors, semiconductor manufacturers, circuit card assembly manufacturers, and government laboratories and test agencies. In addition to addressing the nuclear survivability needs of GCS, the DSA now also is addressing the problems of semiconductor obsolescence and methods to effectively increase the use of commercial semiconductors.

The DSA has established a Radiation Tolerant Assured Supply and Support Center at White Sands Missile Range NM. The Center brings together representatives from the government, semiconductor manufacturers, circuit card manufacturers, and defense system prime contractors to determine and certify that specific semiconductors used in GCS meet GCS nuclear survivability requirements.

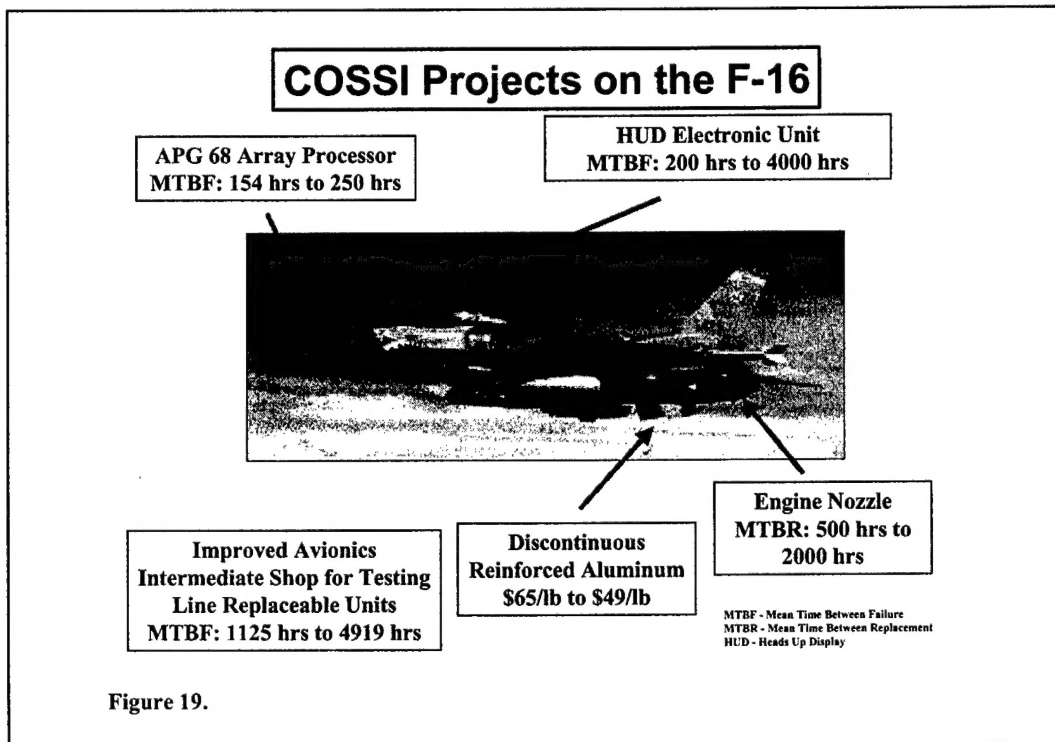
¹² (<http://www.dtic.mil/natibo/>)

5.2 Commercial Technology Insertion

The Department also identifies, adapts, and leverages predominantly commercial and dual use capabilities and products.

Commercial Operations and Support Savings Initiative

Extending the service life of a military system can cause operations and support (O&S) costs to increase. In addition, military-specific components contained in many legacy systems have become obsolete and hard to get at any price. The Commercial Operations and Support Savings Initiative (COSSI) program adapts commercial technologies for use in legacy military systems to reduce O&S costs. COSSI uses an acquisition method that mirrors commercial market practices. It utilizes the Other Transactions for Prototypes Authority provided by section 804 of Public Law 104-201. Other Transaction Authority (OTA) reflects commercial contracting practices and provides more flexibility than traditional government contracts in cost accounting, intellectual property rights, and access to data. It encourages non-traditional suppliers to provide DoD with innovative products and technologies. DoD and the contractor share COSSI project costs. Costs sharing and partnering with industry allow DoD to leverage a commercial firm's technology investments to reduce costs and improve the performance of fielded defense systems. Costs saving and partnering with industry allow DoD to leverage a commercial firm's technology investments to reduce costs and improve the performance of fielded defense systems.



COSSI projects reduce total ownership costs and improve readiness by improving the reliability of legacy systems. Figure 19 illustrates how COSSI projects have improved reliability and reduced costs for key F-16 systems. Improved reliability results in higher readiness and lower costs for operations and maintenance.

COSSI projects promote military-commercial integration by emphasizing the use of commercial components. Military-unique components contained in many legacy systems sometimes become obsolete and hard to get at any price. By acquiring components from commercial production lines and emphasizing open system designs, DoD takes advantage of economies of scale, increases the rate at which legacy systems can be "refreshed" technologically, and mitigates parts obsolescence.

COSSI utilizes a two-stage process. During Stage I, the contractor and DoD share the costs associated with making modifications to the core commercial product to adapt it for military use, produce a prototype, and test the prototype to ensure it meets performance requirements in the selected application and operational environment. If Stage I is successful, the military customer then may enter Stage II by using procurement funds to contract for necessary production quantities.

Congress appropriated \$52 million for COSSI projects in FY 2001. DoD received thirty project proposals in response to its FY2001 solicitation and selected 19 for funding. Among the proposals selected are an electronic propeller control for C-130 aircraft, a new power transfer clutch for the AH-64 helicopter, "sealless" pumps for Navy ships, a new deicing system for P-3 and C-130 aircraft, and an advanced symbol generator for night vision goggles.

Dual Use Science & Technology Program

DoD initiated the Dual Use Science & Technology (DU S&T) Program in FY1997 to increase the insertion of dual use technologies into defense systems. The Program defines a dual use technology as a technology that has both military utility and sufficient commercial potential to support a viable industrial base. Dual use technologies permit DoD to take advantage of the same competitive pressures and market-driven efficiencies that have led to accelerated development and savings in the commercial sector.

The Program jointly funds research projects with industry that develop dual use technology solutions for DoD problems. Since the Program began in FY1997, DoD and industry have invested over \$850 million in over 300 projects to develop dual use technologies. More than half of this funding has come from industry. The Services issue a joint DU S&T solicitation in January of each year requesting industry proposals in specific topic areas:

- Affordable Sensors
- Weapon System Sustainment

- Distributed Mission Training
- Advanced Propulsion, Power, and Fuel Efficiency
- Information and Communications Technology
- Medical and Bioengineering Technologies
- Advanced Materials and Manufacturing
- Environmental Technologies

Joint development of technology with industry provides the Department significant benefits; it:

- Leverages DoD S&T funds by partnering with industry to meet defense needs. During the first three years of the Program, industry participants have invested over \$450 million to develop technologies to meet future defense needs.
- Accesses commercial technologies. Over 70 commercial firms have participated in the Program. Many previously had done little or no business with the DoD.
- Incorporates defense considerations into commercial technologies. Defense funding ensures that technologies or components developed within the Program incorporate unique defense requirements into the design.
- Reduces acquisition and logistics costs. The increased use of commercial technologies provides the Department with the economies of scale of the commercial market and the worldwide logistics support often available from commercial companies.

Many of the projects are beginning to bear fruit. A few examples follow.

Active Braking System for Medium Duty Wheeled Vehicles

Continental Teves has developed an Anti-lock Braking System (ABS) for the Army's High Mobility Multipurpose Wheeled Vehicle (HMMWV) and medium size commercial truck. The braking system will go into production in 2001 with projected commercial sales of at least 80,000 units per year. Because Continental Teves considered the DoD's special requirements during design, its ABS will meet HMMWV requirements with no major modifications.

Besides the obvious benefits of improved braking and safety, DoD also will have access to a commercial product that meets a military requirement at a reduced cost. The ABS developed under this program will be produced on the same line as Continental's commercial ABS and sold to the Army at approximately \$500 per unit. This represents savings of \$1,700 per unit based on earlier estimates of \$2,200 per unit for an ABS developed exclusively for the HMMWV. Savings on retrofits for existing HMMWVs and new production may reach \$100

million. In addition, the Army will have access to worldwide logistics support from Continental Teves.

Affordable Antenna for Weapon System Delivery & Cellular Communications

Raytheon Systems Company is developing an antenna for weapon system delivery that also has commercial cellular communications applications. The cost of the new antenna will be approximately 10 percent of the cost of the antenna currently used for weapon system delivery. As a result of this project, DoD will have access to an affordable airborne antenna that is as capable as current antennas, and more reliable. Over 2,000 commercial versions of the antenna already have been sold for use in telecommunications applications.

Optical Character Recognition

Applications Technology Incorporated, a small commercial business, is developing a highly accurate optical character recognition (OCR) system for Arabic and Persian script. The new OCR system will replace the inadequate systems currently being used. DoD already has transitioned the technology to the Counter Intelligence/Human Intelligence Advanced Concept Technology Demonstration project. Applications Technology has committed funds to develop commercial applications for the technology.

The product will provide the Army an improved capability to collect and analyze intelligence from foreign language documents in low-quality formats, allowing troops in the field to react more quickly to intelligence information. The commercial market for multilingual OCR systems is growing, with special interest in documents from the Arabic world, where electronically represented text is relatively recent and original documents must be scanned and converted.

Thermal Sprayed Nanostructural Coatings

Nanodyne Incorporated, a small commercial business, is leading a consortium developing highly wear and corrosion resistant nanostructured coatings for use on ships, aircraft and land vehicles. The coatings will reduce life-cycle costs and better comply with environmental regulations. This technology will allow DoD to repair components currently being replaced, extend the service life of wear damaged components by a factor of two to five, and eliminate the need for chrome plating for a wide variety of applications. The coatings are a leading candidate for a Secretary of the Navy initiative to fast-track technology into the fleet.

Nanostructured coatings provide similar benefits in commercial industry. Potential commercial applications include automobiles (clutch plates, fuel injectors, piston rings, cylinder walls, and valve seats,) aircraft gas turbine engines, machine tools, and mining equipment. Industry is making additional investments to commercialize the technology.